Load Distribution

نسألكم الدعاء

*IF you download the Free **APP.*** RC Structures YASSER EL LEATHY *on your smart phone or tablet, you will be able to play illustrative movies For any paragraph that has a QR code icon*

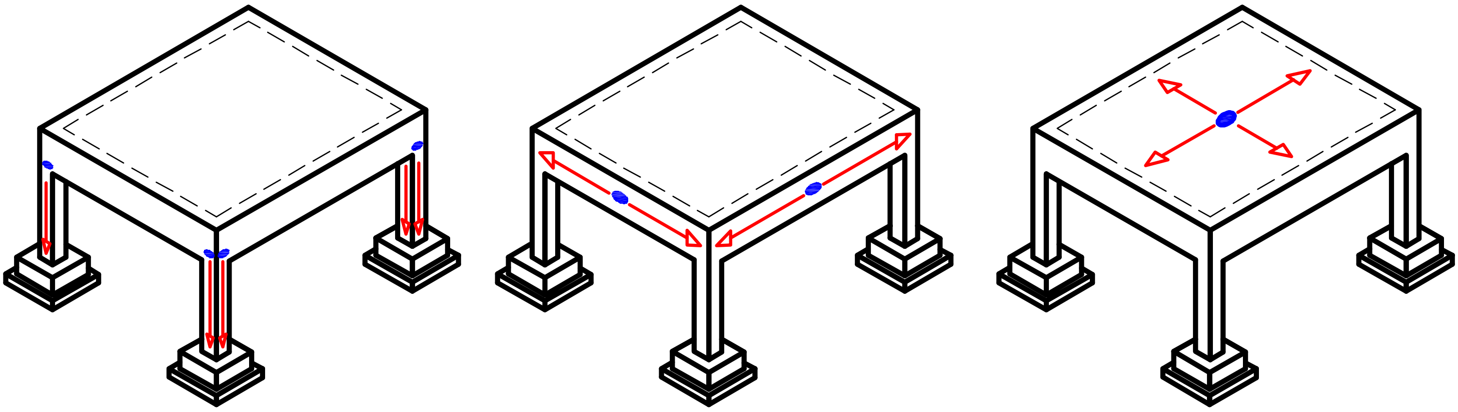
اذا حملت تطبيق RC Structures YASSER EL LEATHY على تليفونك المحمول او اللوح السطحى
ستستطيع أن تشغل أفلام شرح للمقاطع التى تحتوى على رمز

Load Distribution. Table of Contents.

Introduction.

أى حمل موجود فى منشأ ينتقل إلى البلاطه و منه إلى الكمرات و منه إلى الأعمده و منه إلى القواعد و منه إلى الأرض .

* الحمل ⟵ البلاطه ⟵ الكمرات ⟵ الأعمده ⟵ القواعد ⟵ الأرض .



من البلاطه للكمره ⟸ من الكمره للعمود ⟸ من العمود للقاعده

∴ لكى نصمم البلاطات يجب أن نحدد الحمل الواقع عليها .
و لكى نصمم الكمرات يجب أن نحدد الحمل الواقع عليها من البلاطات .
و لكى نصمم الأعمده يجب أن نحدد الحمل الواقع عليها من الكمرات .
و لكى نصمم القواعد يجب أن نحدد الحمل الواقع من الأعمده .

و معنى الـ ***Load Distribution*** هو توزيع الأحمال من البلاطه إلى الكمرات و ذلك لكى نستطيع أن نحدد الأحمال الواقعه على كل كمره لكى نرسم لها الـ ***S.F.D.* ، *B.M.D.*** و عن طريق الـ ***S.F.D.* ، *B.M.D.*** نستطيع أن نصمم الكمره (أى أن نعرف أبعادها و نحدد تسليحها) .

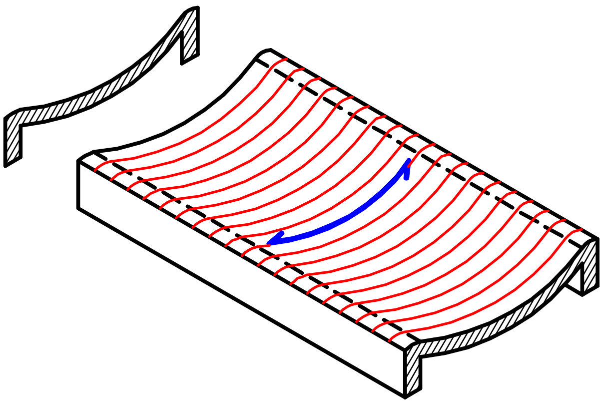
ما سنتناوله فى هذا الملف هو توزيع الاحمال للبلاطات الـ **Solid Slabs** فقط و ليس أى نوع أخر من البلاطات .

Types of Slabs. أنواع البلاطات

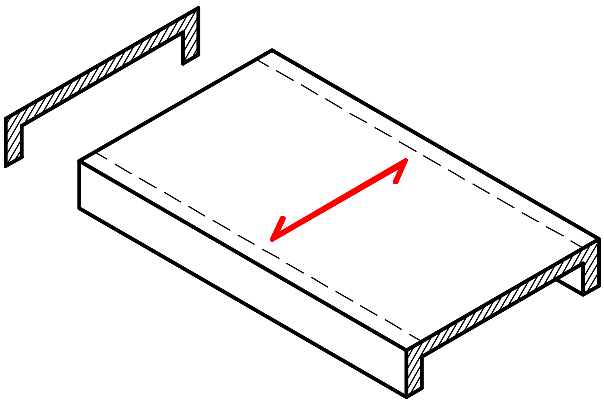
يتم تقسيم البلاطات على حسب الاتجاهات التى يسير فيها الحمل .

① One Way Solid Slab.

الـ **One Way Slab** هى عباره عن بلاطه يسير فيها الحمل فى إتجاه واحد فقط.



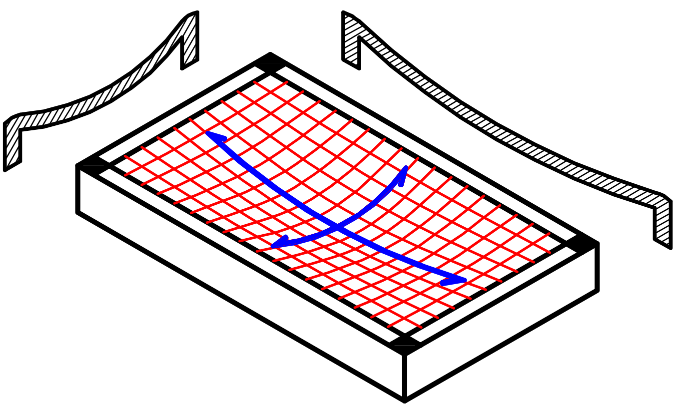
After Loading



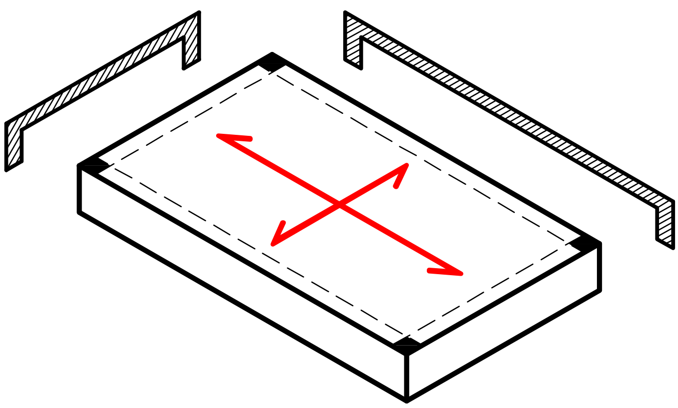
Before Loading

② Two Way Solid Slab.

الـ **Two Way Slab** هى عباره عن بلاطه يسير فيها الحمل فى الإتجاهين .



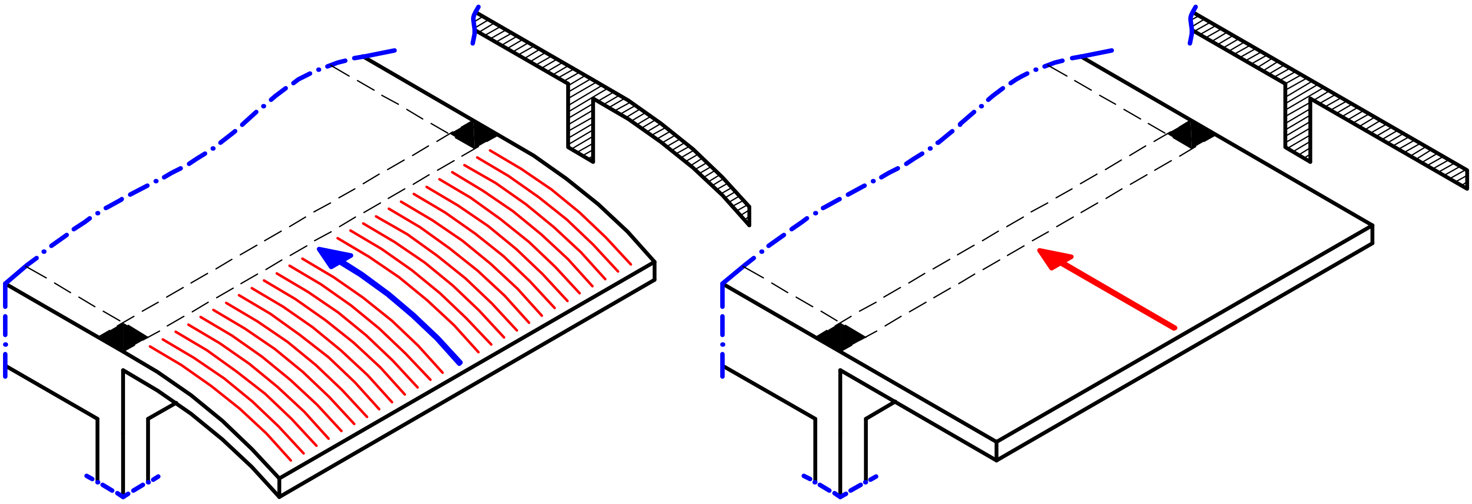
Before Loading



Before Loading

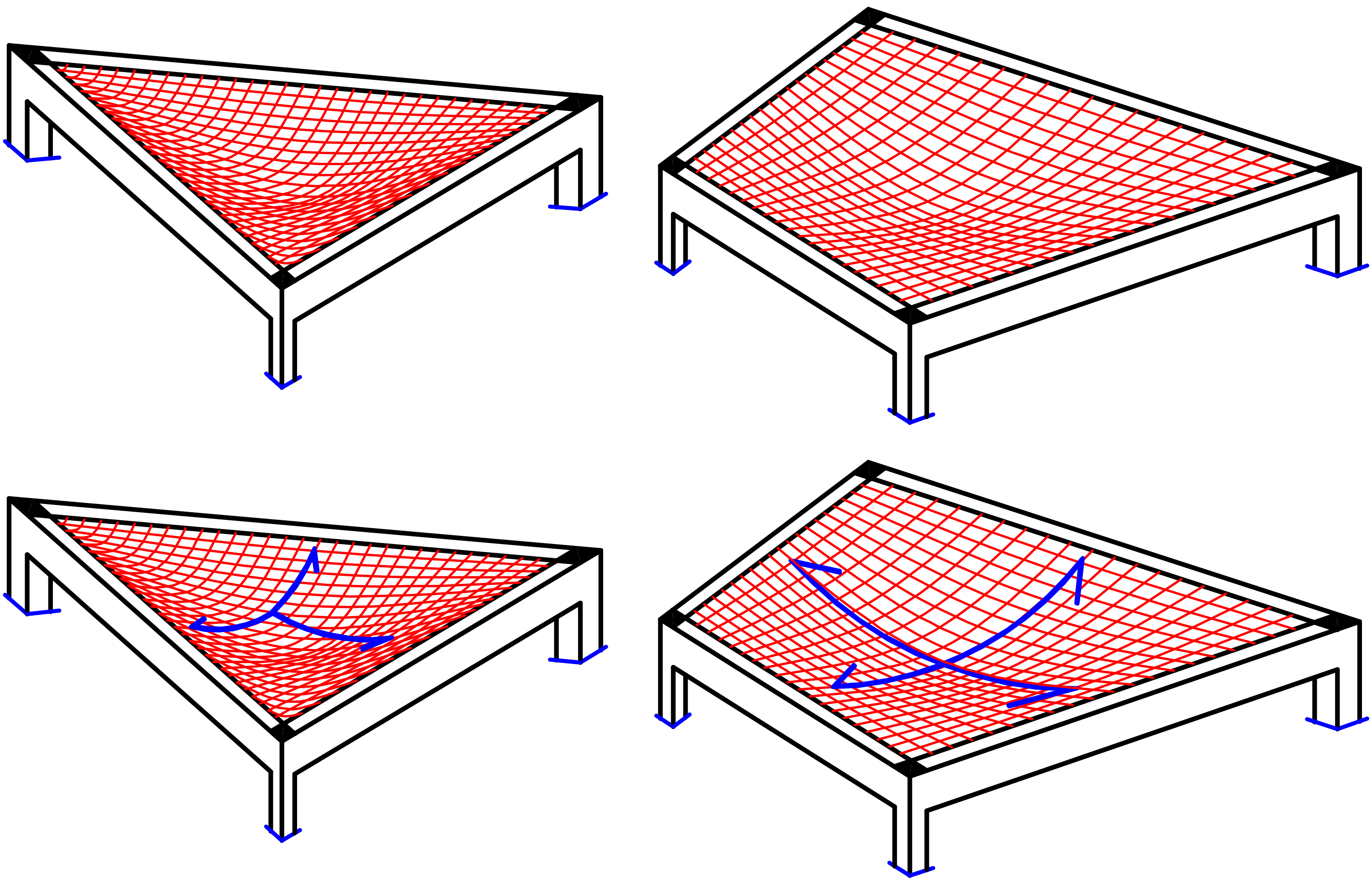
③ Cantilever Solid Slab.

ال **Cantilever Slab** هى عباره عن بلاطه محموله على كمره واحده .



④ Irregular Solid Slabs.

ال **Irregular Slabs** هى بلاطات أشكالها غير منتظمه (أى ليست مستطيله او مربعه) .



Load Distribution Pattern For Slabs.

توزيع أحمال البلاطات على الكمرات هى طريقه معقده للغايه
و تعتمد على عوامل كثيره أهمها :

١ـ نسبه أبعاد البلاطه لبعضها و استمراريتها فى الاتجاهين *rectangularity* (r)

٢ـ حاله ارتكاز البلاطه على الكمره (مصبوبين معاً أم لا).

٣ـ نسبه تخانه البلاطه الى الكمره *relative stiffness*.

٤ـ تفاصيل التسلح بين البلاطه و الكمره *hinged or rigid joint*.

٥ـ توزيع الاعمده و طريقه اتصالها مع الكمرات و البلاطات.

و للتسهيل سيتم توزيع أحمال البلاطات على الكمره حسب الشكل النهائى المتوقع لانهيارالبلاطه (*Yield Line Theory*)

① *One Way Slab.*

المحموله على كمرتين متوازيتين فقط

لتوزيع الـ *Load* على الكمرات يتم عمل خط فى منتصف البلاطه موازى للكمرتين.

المحموله على ٤ كمرات

لتوزيع الـ *Load* على الكمرات يتم عمل خط فى منتصف البلاطه موازى للكمرتين الاطول.

② *Two Way Slab.*

لتحديد الحمل الذى تحمله كل كمره على حده يتم تنصيف الزوايا بين الكمرات

③ *Irregular Slab.*

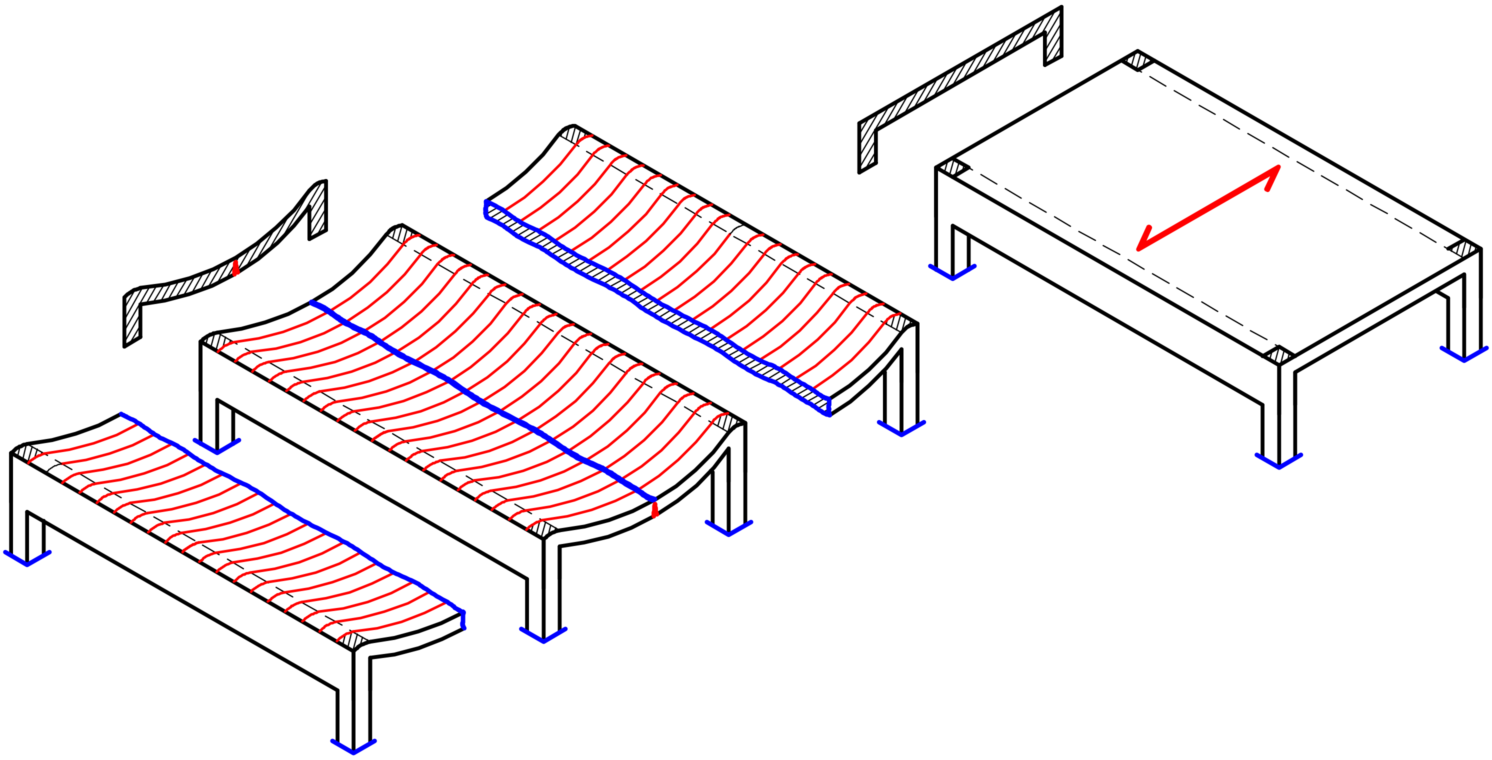
لتحديد الحمل الذى تحمله كل كمره على حده يتم تنصيف الزوايا بين الكمرات

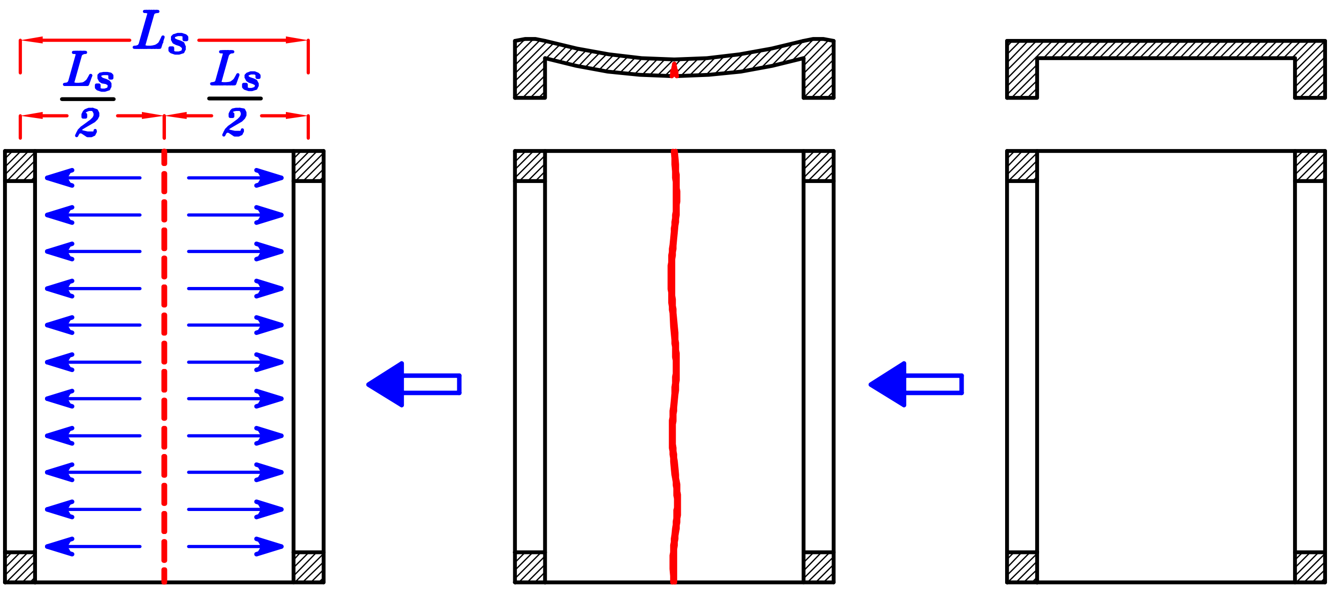
④ *Cantilever Slab.*

لان البلاطه الـ *Cantilever* محموله بالكامل على الكمره
فلا يوجد توزيع للاحمال انما البلاطه كلها محموله على نفس الكمره

1- For Rectangular Slabs rested on 2 parallel Beams.

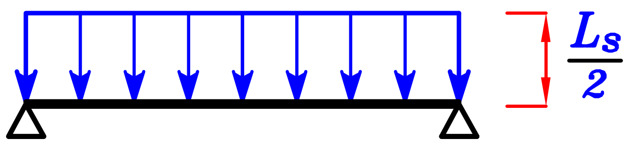
البلاطات المستطيله المحموله على كمرتين متوازيتين .





البلاطه المحموله على كمرتين متوازيتين تكون دائما One Way

و لتوزيع الـ **Load** على الكمرات يتم عمل خط فى منتصف البلاطه موازى للكمرتين .



2- For Rectangular Slabs rested on 4 Beams.

البلاطات المستطيله المحموله على ٤ كمرات

البلاطات المحموله على أربع كمرات ممكن أن تكون *one way* أى الحمل يسير فى اتجاه واحد
أو ممكن أن تكون *Two way* أى الحمل يسير فى الاتجاهين .
و لتحدد اذا كانت البلاطه *one way or Two way* نحسب معامل استطاله البلاطه (r)

(r) Degree of rectangularity. معامل استطاله البلاطه

$$r = \frac{m\,L}{\grave{m}\,L_s}$$

L ---- الطول الكبير للبلاطه

L_s ---- الطول الصغير للبلاطه

m , $\grave{m}$ are Factors depend on the Continuity of the slab strip.

the strip			
m OR $\grave{m}$	1.0	0.87	0.76

IF $\boxed{r > 2.0}$ ∴ the Slab is One way slab.

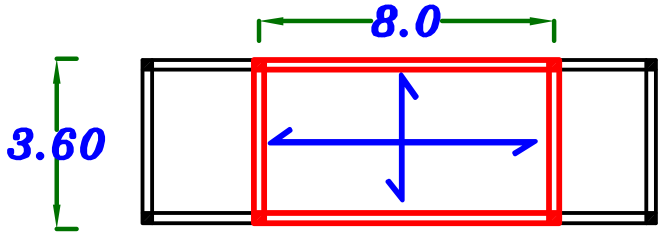
الحمل كله يسير فى اتجاه واحد فقط هو الاتجاه القصير (الموجود فى أسفل فى المقام).

IF $\boxed{r \leqslant 2.0}$ ∴ the Slab is Two way slab. الحمل يسير فى الاتجاهين

Example.

$$r = \frac{0.76\,(8.0)}{1.0\,(3.60)} = 1.68 < 2.0$$

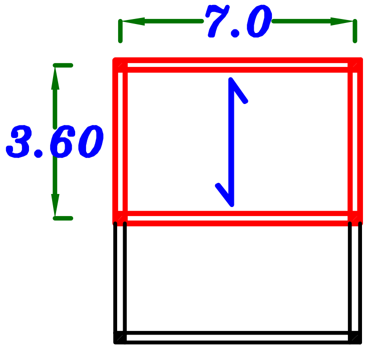
Two way



Example.

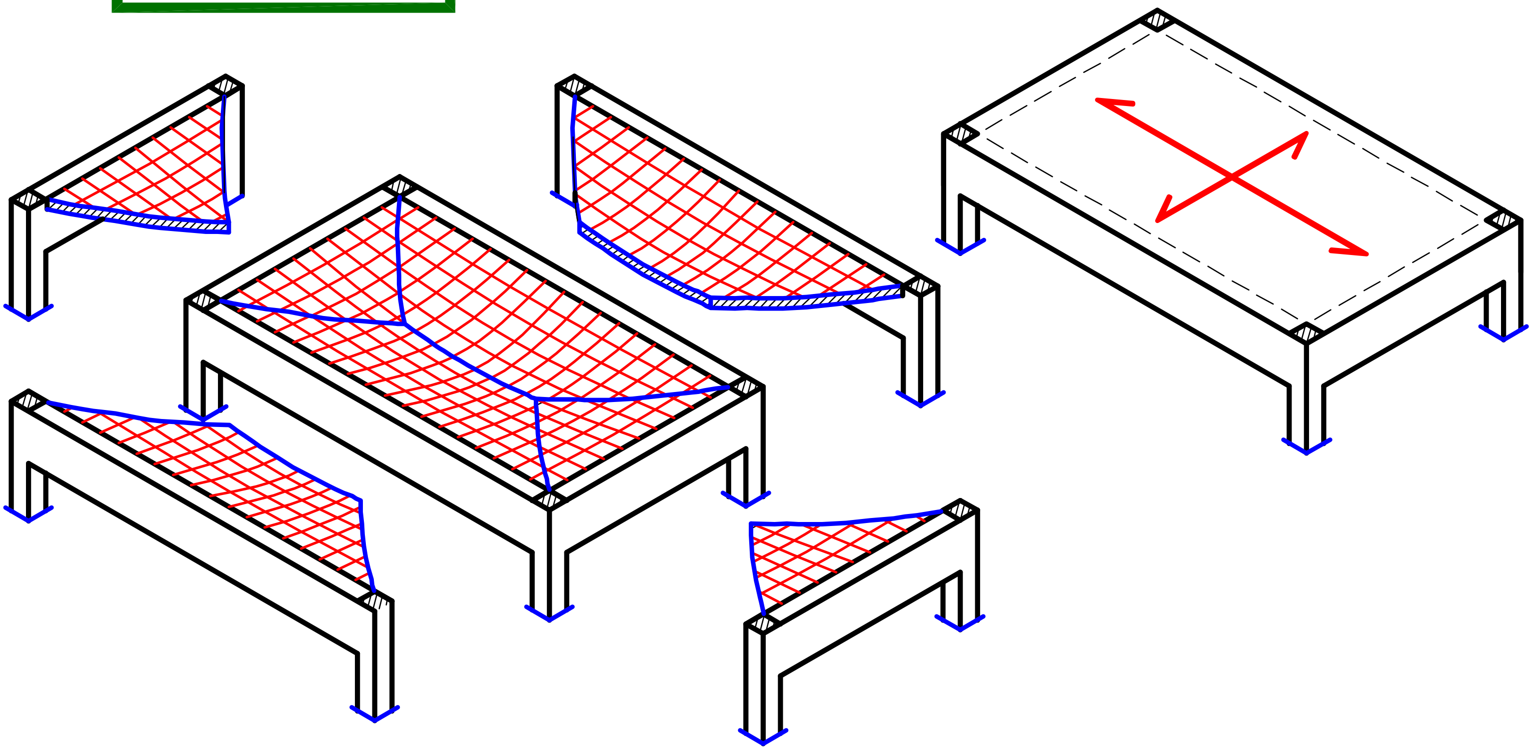
$$r = \frac{1.0\,(7.0)}{0.87\,(3.60)} = 2.23 > 2.0$$

One way

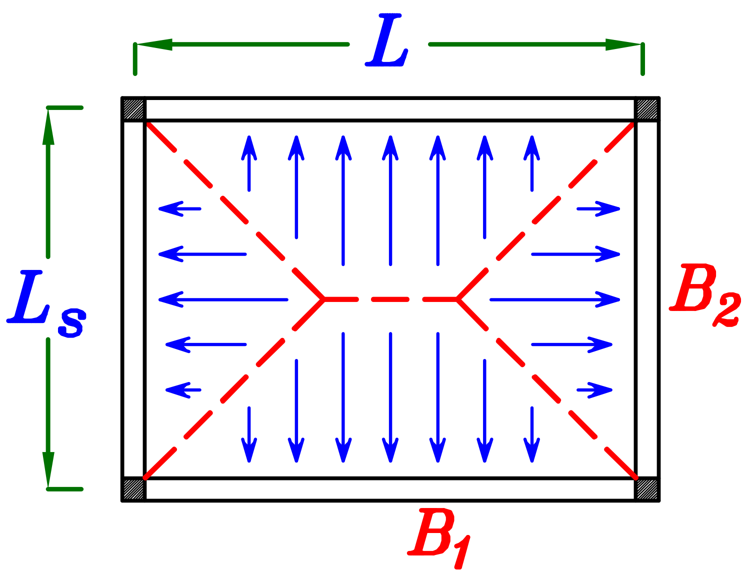


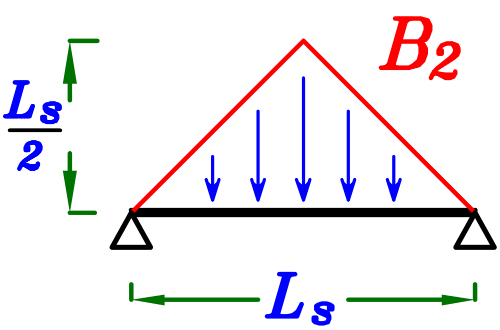
$$\boxed{r = \frac{L}{L_s}}$$ فى هذا الملف للتسهيل سنعتبر

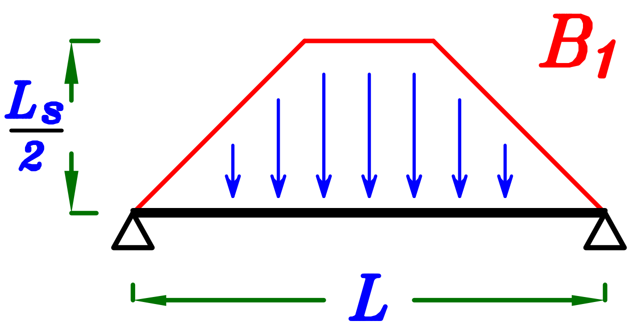
$\frac{L}{L_s} \leqslant 2.0$ Two way الحمل يسير فى الاتجاهين



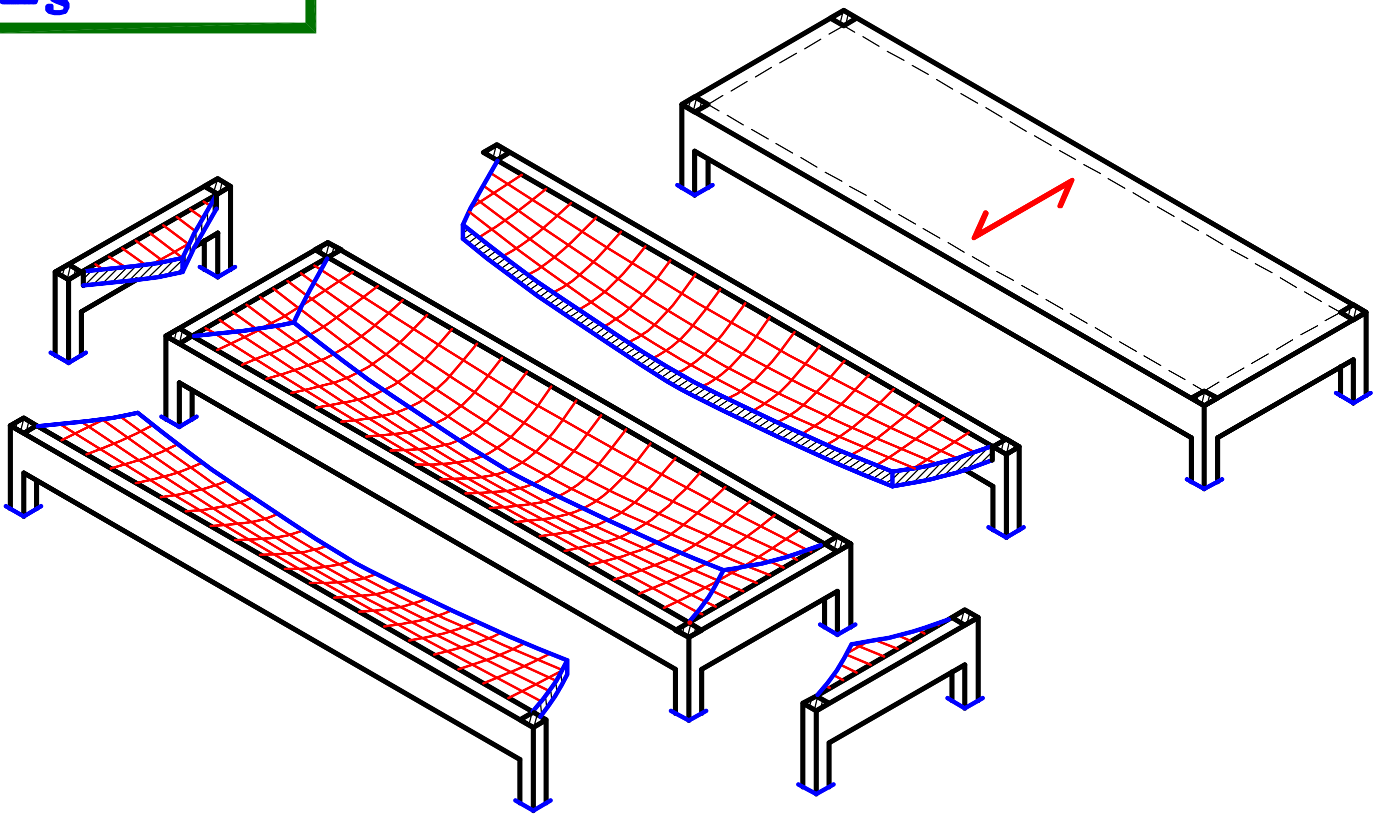
لتحديد الحمل الذى تحمله كل كمره على حده يتم تنصيف الزوايا بين الكمرات







$$\frac{L}{L_s} > 2.0$$ One way نعتبر الحمل يسير فى الاتجاه القصير فقط

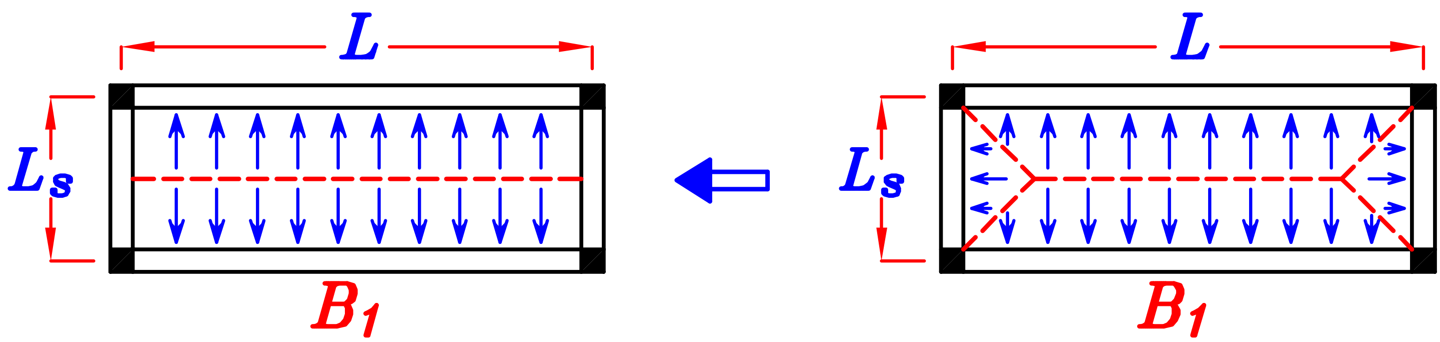


عند تصنيف الزوايا بين الكمرات

سيظهر أن الكمره الطويله تحمل نسبه كبيره جدا من الحمل

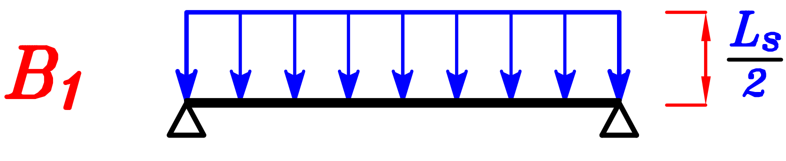
و الكمره القصيره تحمل جزء قليل جدا من الحمل

لذا نعتبرها بلاطه One way فى الاتجاه الاقصر فقط.

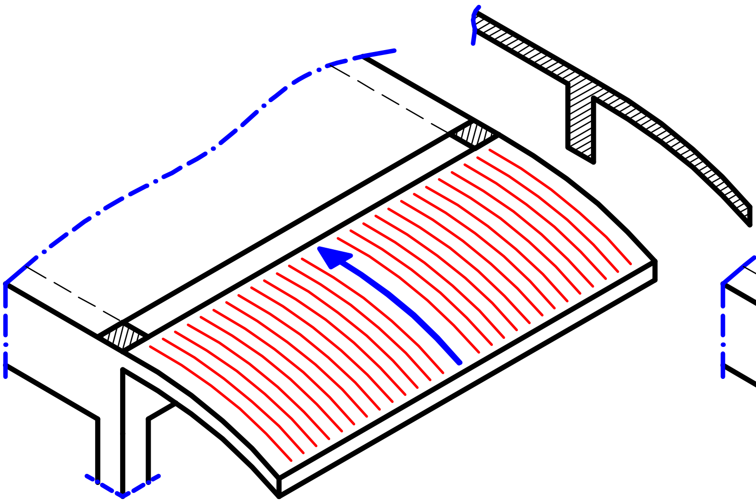


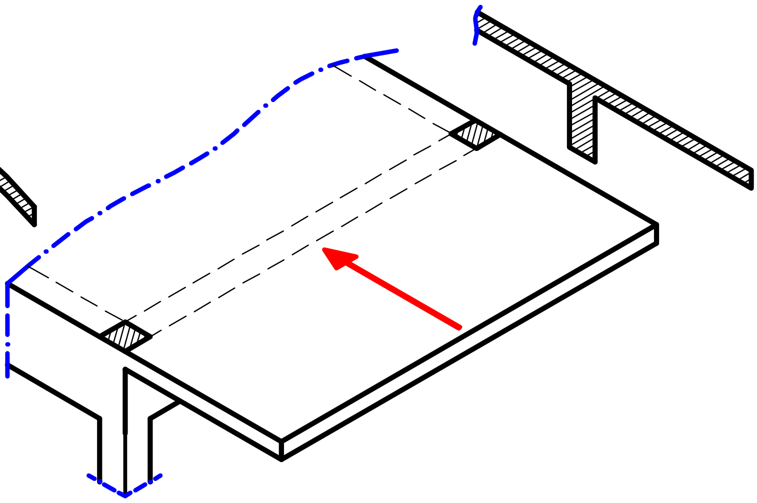
توزيع الحمل فى البلاطات الـ One way ذات الـ ٤ كمرات

يكون بعمل خط موازى للكمرتين الاطول .

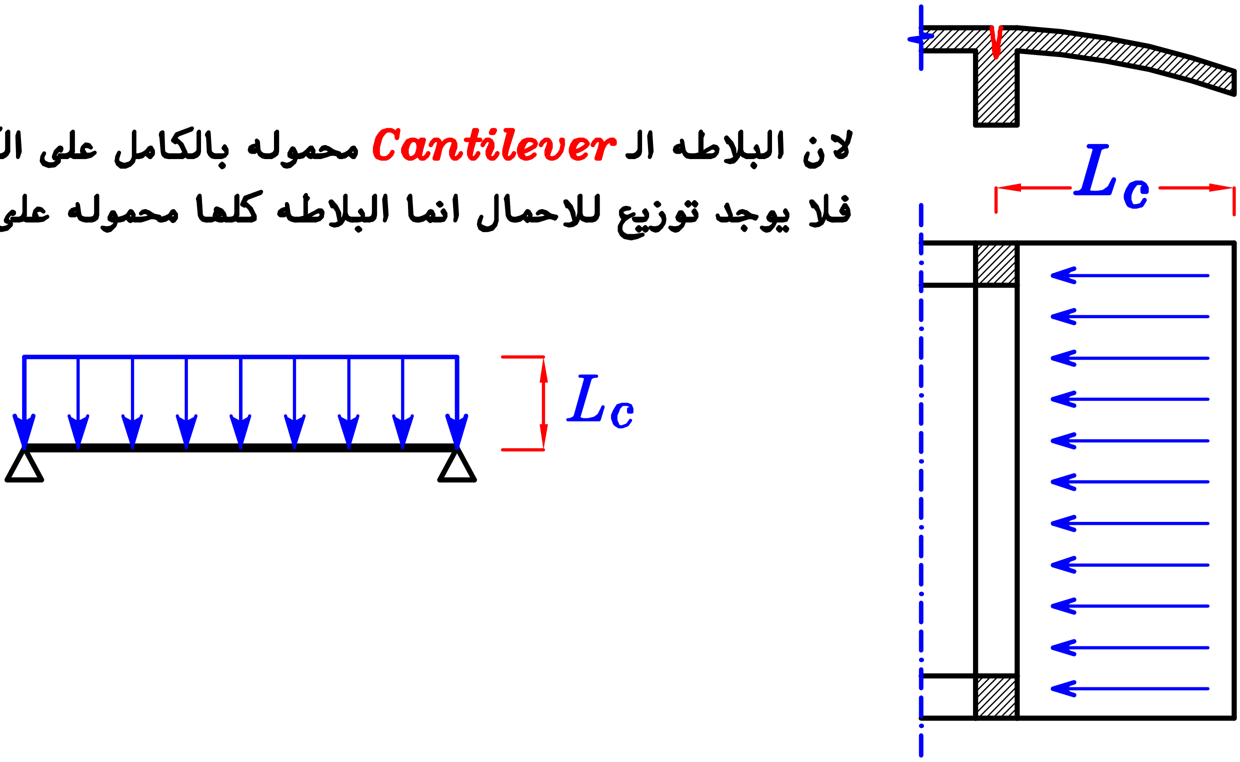


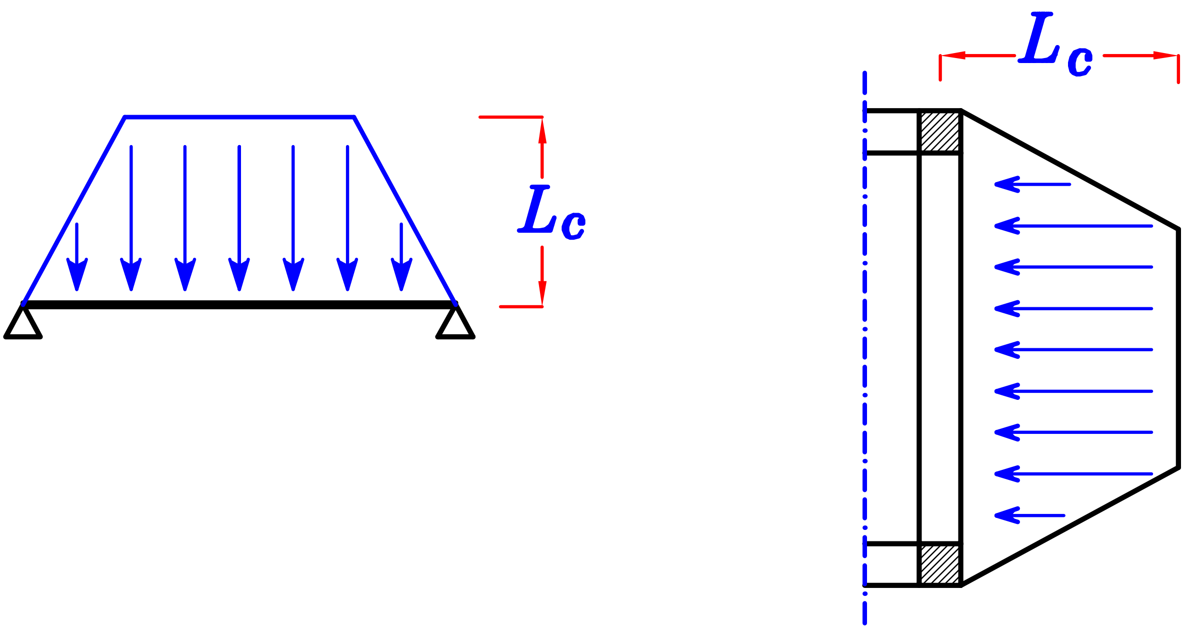
3 - For Cantilever Slabs .





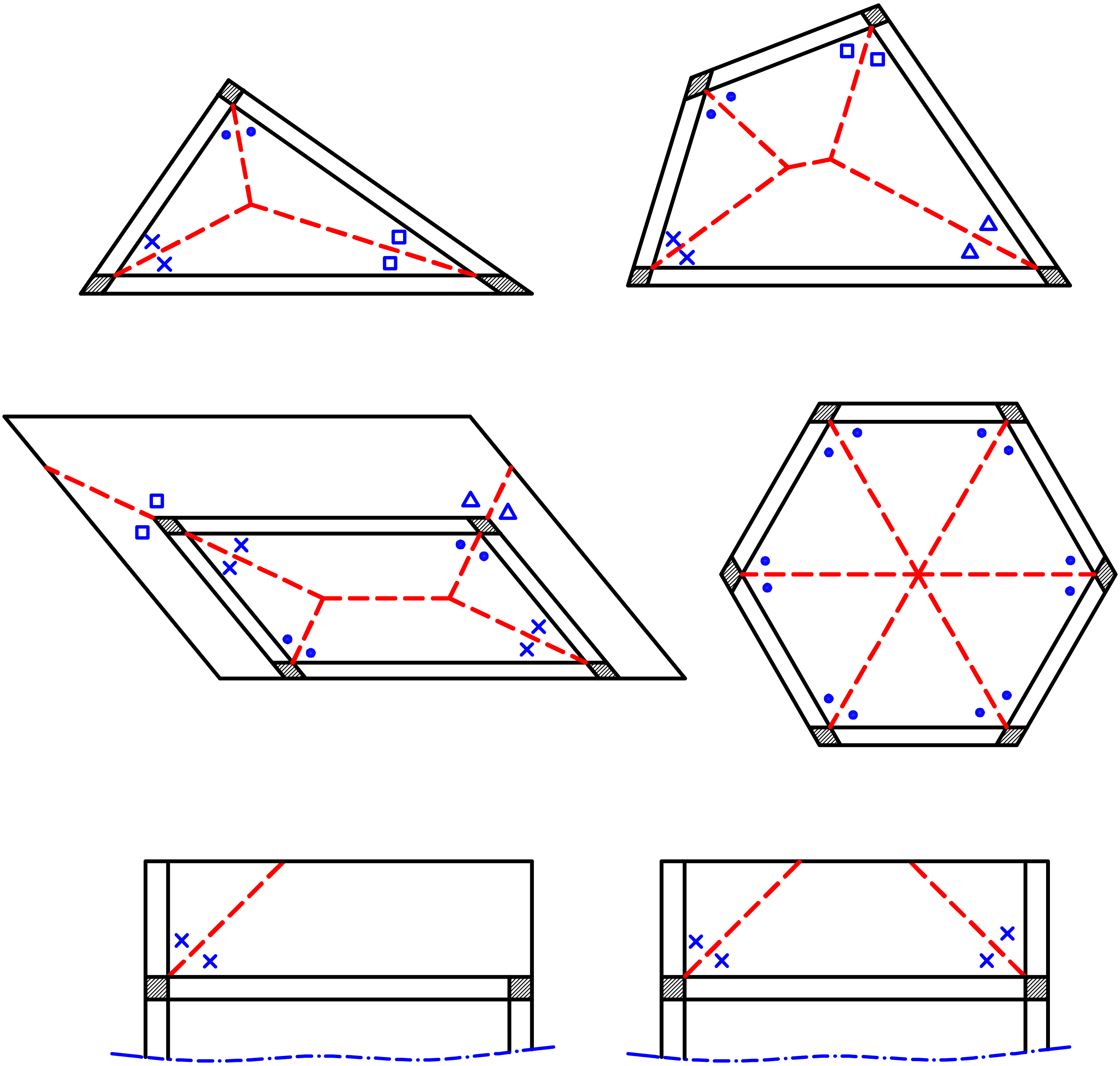
لان البلاطه الـ Cantilever محموله بالكامل على الكمره
فلا يوجد توزيع للاحمال انما البلاطه كلها محموله على نفس الكمره





4- For Irregular Slabs .

لتحديد الحمل الذى تحمله كل كمره على حده يتم تنصيف الزوايا بين الكمرات

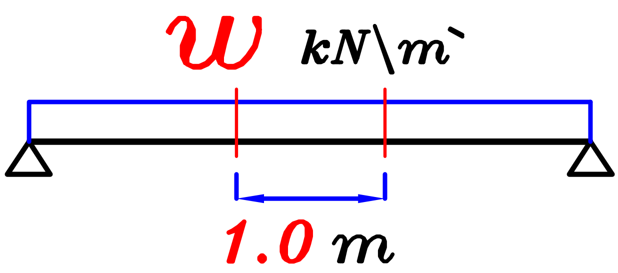


Calculation of loads on Beams.

لكى نصمم الكمره لاحقا يجب أن نرسم أولاً **B.M.D. & S.F.D.**

و لكى نرسم **B.M.D. & S.F.D.** يجب أولا أن نحسب قيمه (w).

حيث (w) هى الحمل الموجود على الكمره فى المتر الطولى الواحد .



w = O.W. of the beam + Weight of the wall + Weight From the slab.

$$\boxed{w = o.w._{(beam)} + walls + Slabs = \checkmark \ kN\backslash m`}$$

أى أن الوزن الواقع على متر طولى من الكمره يتكون من ثلاث أشياء :

① o.w. of the beam.

١ـ وزن الكمره نفسـها . (وزن متر طولى من الكمره).

② Weight of walls.

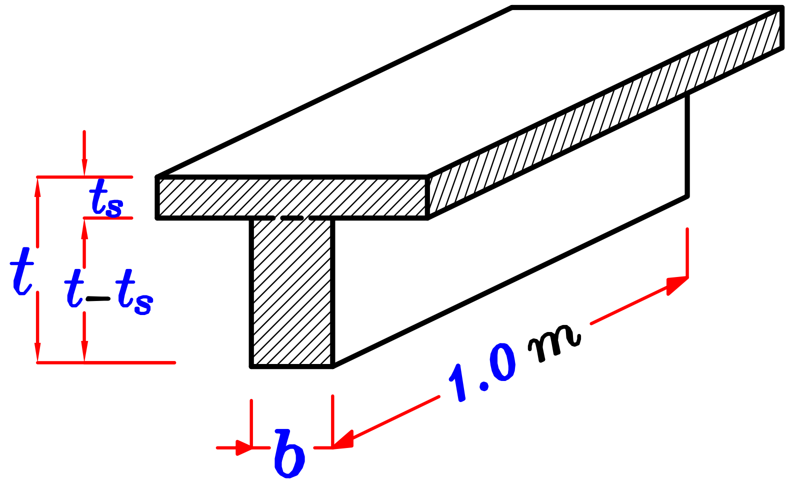
٢ـ وزن الحوائط التى تحملها الكمره . (وزن متر طولى من الحائط).

③ Loads From the slab.

٣ـ وزن البلاطه الواقع على الكمره . (وزن البلاطه المحمول على متر طولى من الكمره).

① o.w. of the beam (own weight)

نحسب وزن الكمره فى المتر الطولى



$$\boxed{\text{Density of R.C. } (\gamma_c) = 25\ kN\backslash m^3}$$

$$o.w._{(beam)} = \text{Volume} * \text{Density}$$

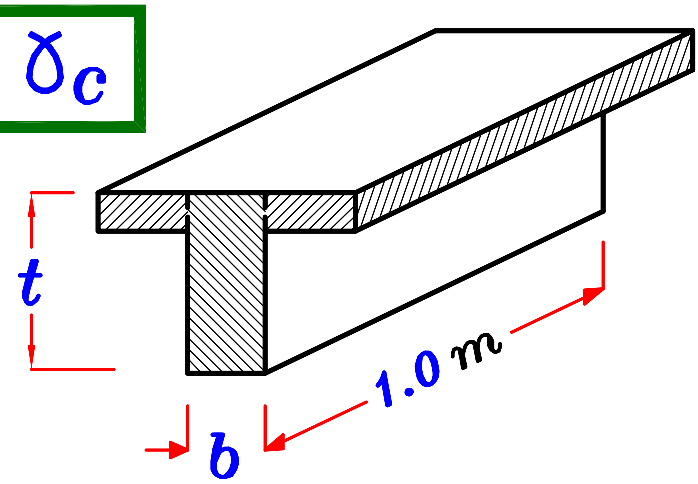
$$= \left[(b)(t-t_s)(1.0)\right] * \gamma_c$$

$$\boxed{o.w._{(beam)} = (b)\,(t-t_s)\,\gamma_c} \quad kN\backslash m'$$

و لكن للتسهيل و فى نفس الوقت **more safe**

سنأخذ وزن المتر الطولى من الكمره

$$\boxed{o.w._{(beam)} = (b)\,(t)\,\gamma_c}$$



ملاحظات :

١ـ إذا كانت أبعاد الكمره معروفه $(b * t)$

Example.

$(250 * 600) \longrightarrow b = 250\ mm = 0.25\ m\ ,\quad t = 600\ mm = 0.60\ m$

نحسب وزن المتر الطولى كما سبق :

$$o.w._{(beam)} = (b)\,(t)\,\gamma_c = (0.25)\,(0.60)\,(25) = 3.75\ kN\backslash m`$$

Example.

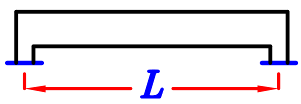
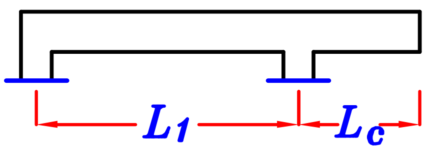
٢ـ لو الوزن معطى مباشره (تم فرضه) :

Take $o.w._{(beam)} = 3.0\ kN\backslash m`$

و فى هذه الحاله لا نحسب قيمه ال $o.w.$
بل نأخذ القيمه المُعطاه مباشره .

٣ـ من الممكن ان تكون ابعاد الكمره غير معطاه فنفرضها كالتالى :

Take $b = 250\ mm$

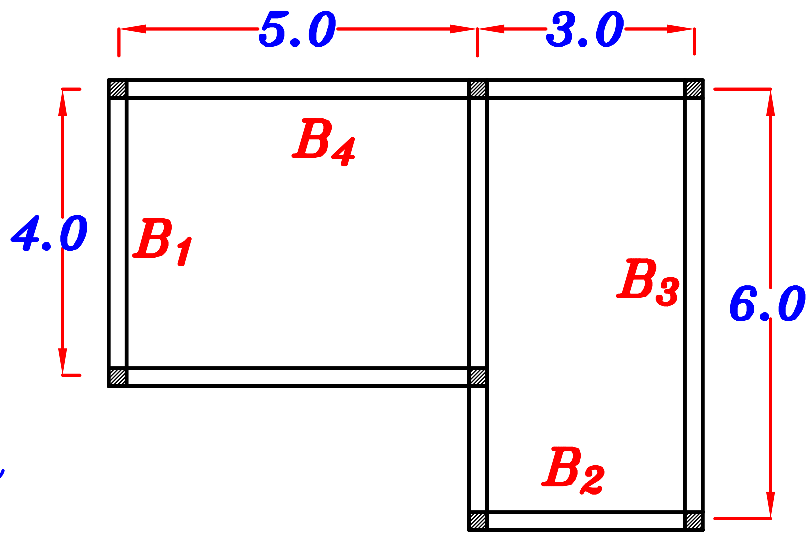
Type of beam	Thickness (t)
Simple Beam 	$t = \frac{L}{10}$
Continuous Beam 	$t = \frac{L_{bigger}}{12}$
Beam with Cantilever 	$t = \left.\begin{matrix} \frac{L_1}{12} \\ \frac{L_c}{5} \end{matrix}\right\}$ الأكبر

و تقرب (t) لأقرب ٥٠ مم بالزياده.

و أقل (t) للكمره = ٤٠٠ مم (٤٠ سم) $\quad t_{min} = 400\ mm$

Example.

Estimate the thickness of the beams.

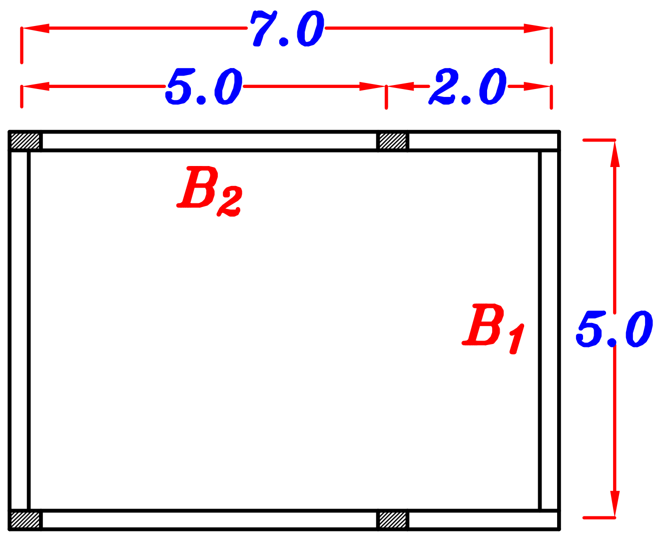


B1 $t_1 = \frac{4}{10} = 0.40\ m$

B2 $t_2 = \frac{3}{10} = 0.3\ m < 0.40\ m \quad \therefore t_2 = 0.4\ m$

B3 $t_3 = \frac{6}{10} = 0.60\ m$

B4 $t_4 = \frac{5}{12} = 0.416\ m = 0.45\ m$



B1 $t_1 = \frac{5}{10} = 0.50\ m$

B2 $t_2 = \left.\begin{array}{l} \frac{5}{12} = 0.416\ m \\ \frac{2}{5} = 0.40\ m \end{array}\right\}$

$= 0.416\ m = 0.45\ m$

But B1 supported on B2

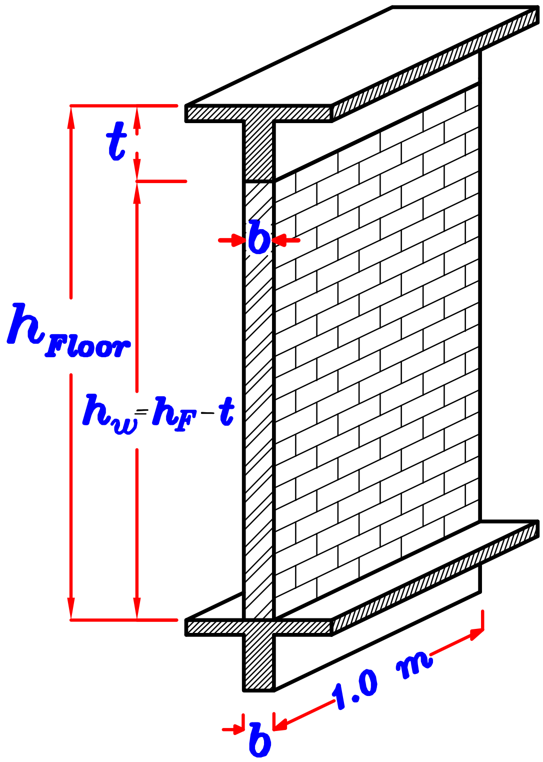
$\therefore$ Take $t_2 = t_1 = 0.50\ m$

② Weight of walls.

وزن الحائط فى المتر الطولى

١- إذا كان المعطى هو ($\gamma_w = \checkmark \ kN\backslash m^3$) أى كثافه الحائط .

$$\boxed{\gamma_w = \checkmark \ kN\backslash m^3}$$



$$(w)_w = Volume * Density$$

$$= (b * h_w * 1.0)\ \gamma_w$$

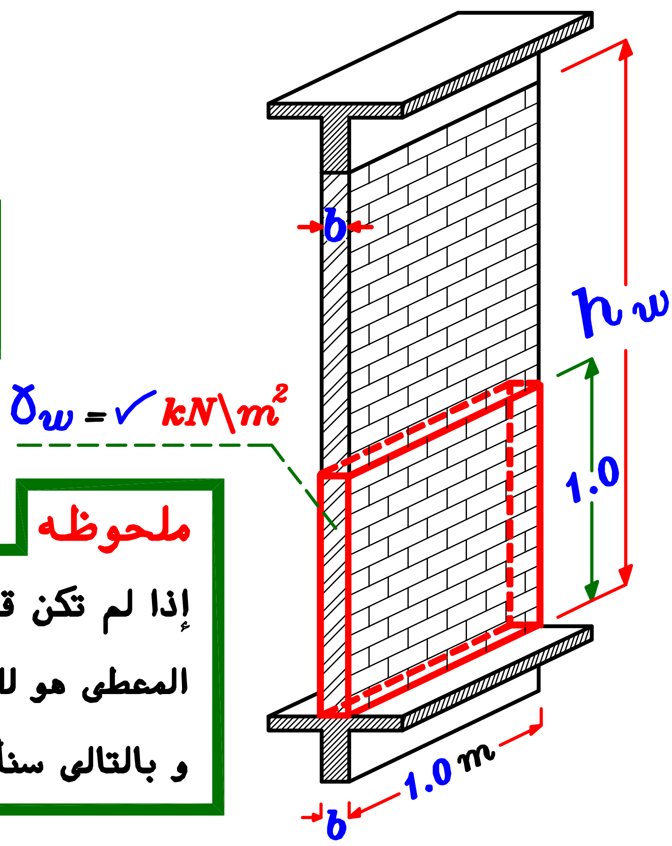
$$= \checkmark \ kN\backslash m'$$

$$\boxed{(w)_w = b * h_w * \gamma_w}$$

٢- إذا كان المعطى هو ($\gamma_w = \checkmark kN\backslash m^2$) أى وزن المتر المربع من الحائط .

$$\boxed{\gamma_w = \checkmark \ kN\backslash m^2}$$

$$\boxed{(w)_w = h_w * \gamma_w}$$



ملحوظه

إذا لم تكن قيمه γ_w معطاه فسنفرض ان ال ***plan*** المعطى هو للدور الاخير اى ان كمراته لا تحمل فوقها حوائط و بالتالى سنأخذ وزن الحوائط فى هذه الحالة تساوى ***Zero***

③ Loads From slab.

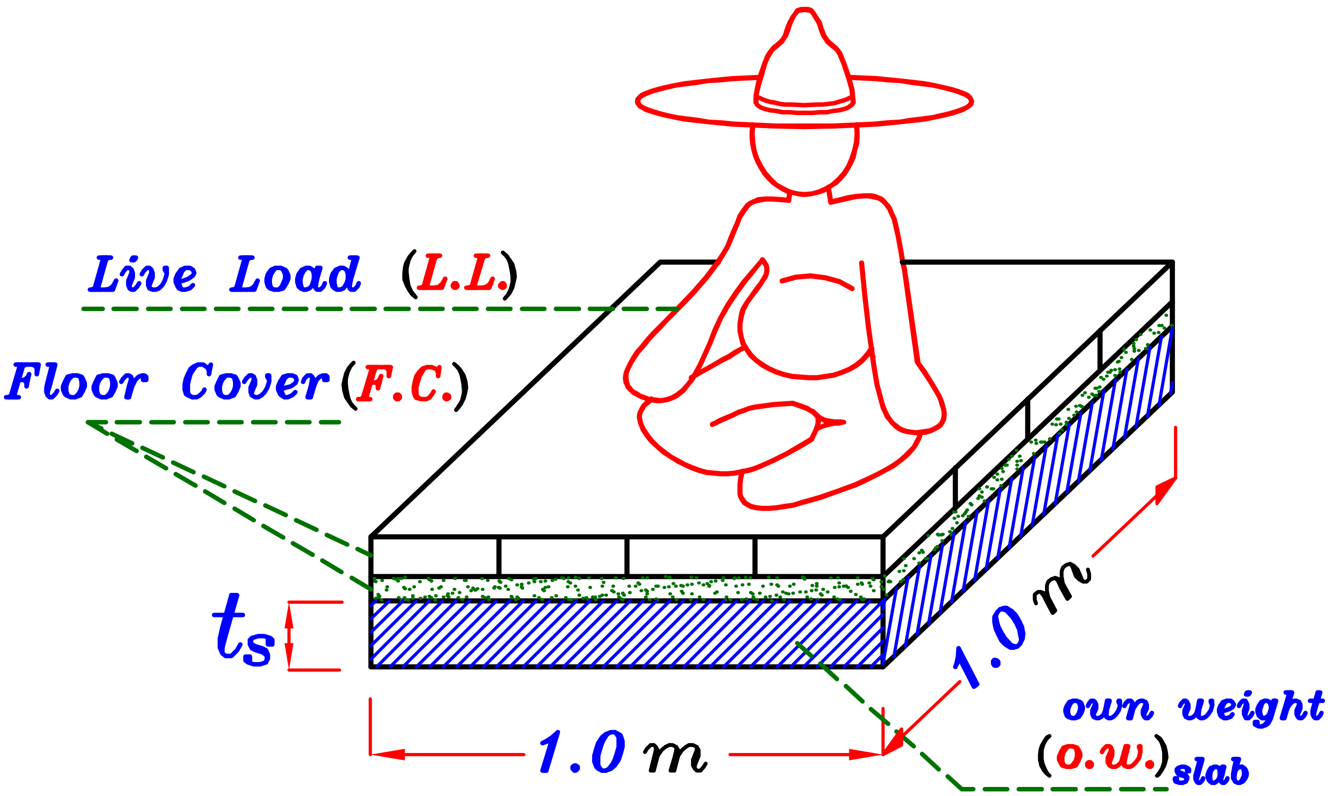
حمل البلاطه يذهب إلى الكمره .

و توزيع هذا الحمل يتوقف على نوع البلاطه و عدد الكمرات .

و لكى نحسب حمل البلاطه الذاهب إلى الكمره

يجب أولاً أن نحدد الحمل على متر مربع من البلاطه و يسمى (w_s)

و هذا الحمل يتكون من ثلاثة أشياء :



ⓐ Own Weight of the slab. (o.w.)

نحسب وزن البلاطه لـ ١,٠ م٢ فقط

$$(o.w.)_{slab} = Volume * Density$$

$$= (t_s * 1.0 * 1.0)\ \gamma_c = \checkmark\ kN\backslash m^2$$

$$\boxed{(o.w.)_{slab} = t_s * \gamma_c} \quad (kN\backslash m^2)$$

ملحوظه وحدات الـ t_s بالمتر

(b) Floor Cover. (F.C.)

هو وزن الأرضيه + الرمل.

و يتوقف على نوع الأرضيه (خشب باركيه أو بلاط أو سيراميك ...... ألخ).

و إذا لم يذكر أى معلومات عن نوع الأرضيه نأخذ $\boxed{F.C. = 1.50\ kN\backslash m^2}$

(c) Live Load. (L.L.)

و هى الأحمال الحيه التى ممكن أن تتحرك أو يتغير مكانها

مثل (الناس أو الأثاث ...... ألخ)

و تختلف قيمه الأحمال الحيه حسب إختلاف إستعمال المنشأ و هى كالأتى :

مبنى سكنى ⟵ $L.L. = 2.0\ kN\backslash m^2$

مبنى إدارى أو مدرسه ⟵ $L.L. = 3.0\ kN\backslash m^2$

سينما أو مسرح ⟵ $L.L. = 5.0\ kN\backslash m^2$

مكتبه أو مخزن ⟵ $L.L. = 10.0\ kN\backslash m^2$

فى البيوت السكنيه غالباً يكون L.L. $\boxed{L.L. = 2.0\ kN\backslash m^2}$

Load of $1.0\ m^2$ of the slab. (w_s)

(w_s) هى الوزن الواقع على ١,٠ م٢ من البلاطه

$$w_s = D.L. + L.L. = (o.w. + F.C.) + L.L.$$

$$= (t_s * \gamma_c + F.C.) + L.L.$$

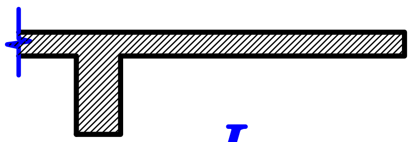
$$\boxed{w_s = t_s * \gamma_c + F.C. + L.L.} \quad (kN\backslash m^2)$$

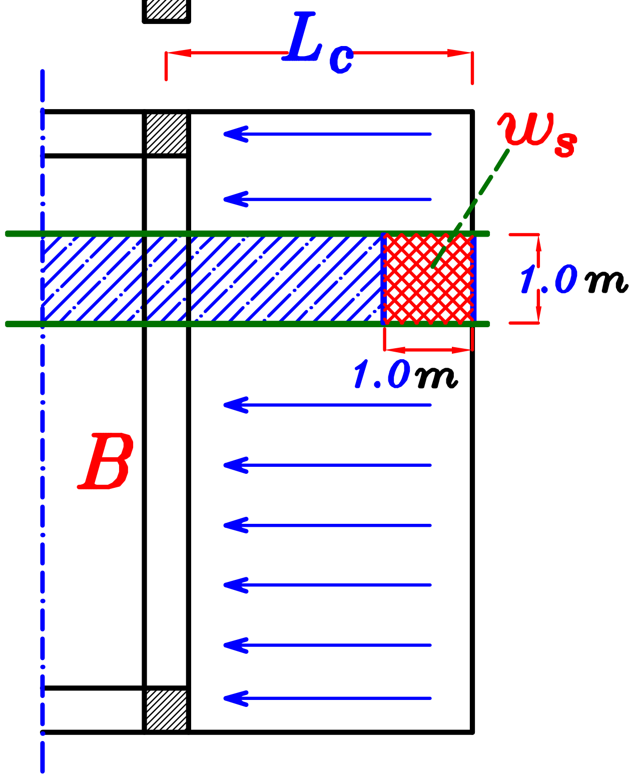
بعد تحديد وزن البلاطه فى المتر المربع w_s .

نحدد حمل البلاطه الواقع على الكمره .

حيث يتوقف هذا الحمل على نوع البلاطه و عدد الكمرات .

① Cantilever Slab.



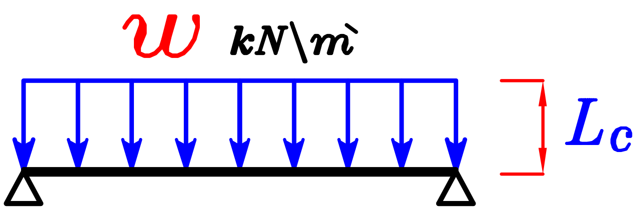


∵ الحمل على المتر المربع من البلاطه $= w_s$

∵ الكمره تحمل طول من البلاطه $= L_c$

∴ الوزن على المتر الطولى من الكمره $= w$

$$\boxed{w = o.w._{(beam)} + walls + w_s\, L_c} \quad kN\backslash m'$$



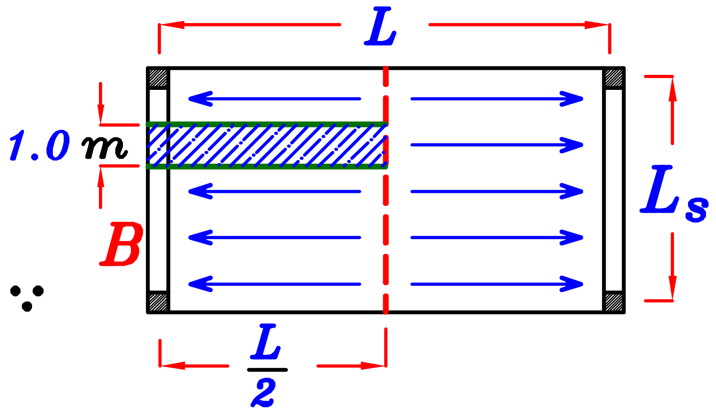
② One Way Slab.

ال **One Way Slab** هى عباره عن بلاطه يسير فيها الحمل **فى إتجاه واحد فقط**.

يوجد نوعان للبلاطات ال **One Way** .

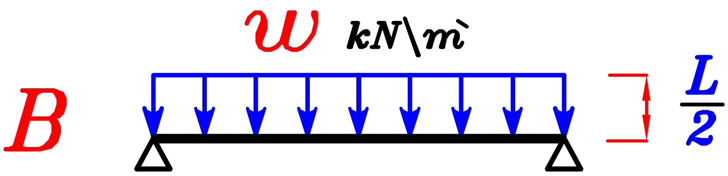
ⓐ Two beams only.

1– (Long Direction)

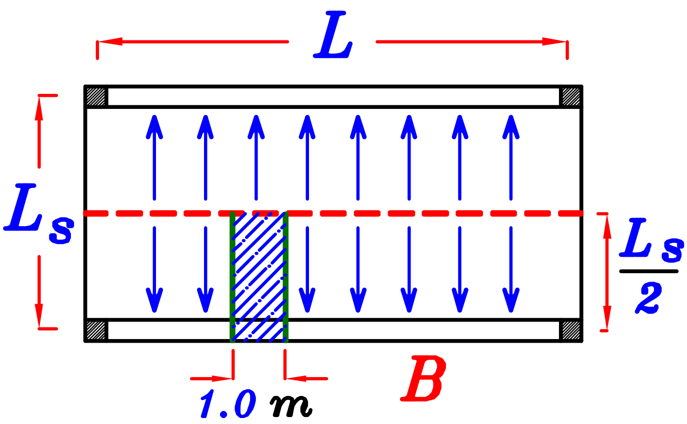


∵ الكمره تحمل طول من البلاطه $= \frac{L}{2}$

$$\boxed{w = o.w._{(beam)} + walls + w_s \frac{L}{2}} \quad kN\backslash m`$$

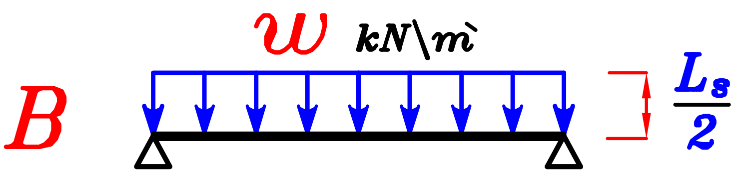


2– (Short Direction)



∵ الكمره تحمل طول من البلاطه $= \frac{L_s}{2}$

$$\boxed{w = o.w._{(beam)} + walls + w_s \frac{L_s}{2}} \quad kN\backslash m`$$



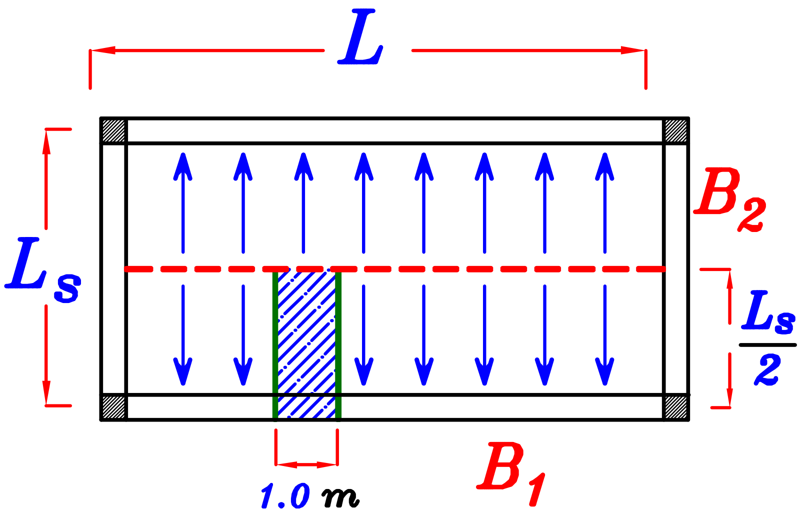
ⓑ Four beams.

شرط لكى تكون البلاطه One Way Slab

و بها ٤ كمرات يجب أن يكون $\boxed{\frac{L}{L_s} > 2.0}$

L = Longer Length

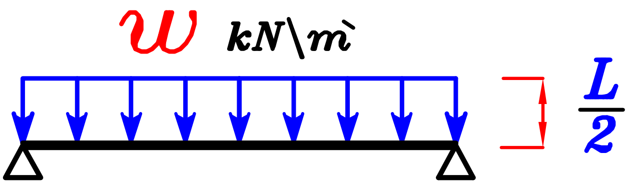
L_s = Shorter Length



B1 الكمره تحمل طول $\frac{L_s}{2}$ من البلاطه

$$\boxed{w = o.w._{(beam)} + walls + w_s \frac{L_s}{2}} \quad kN\backslash m'$$

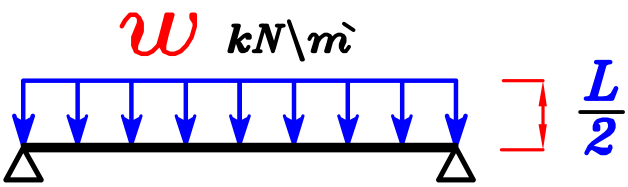
B1



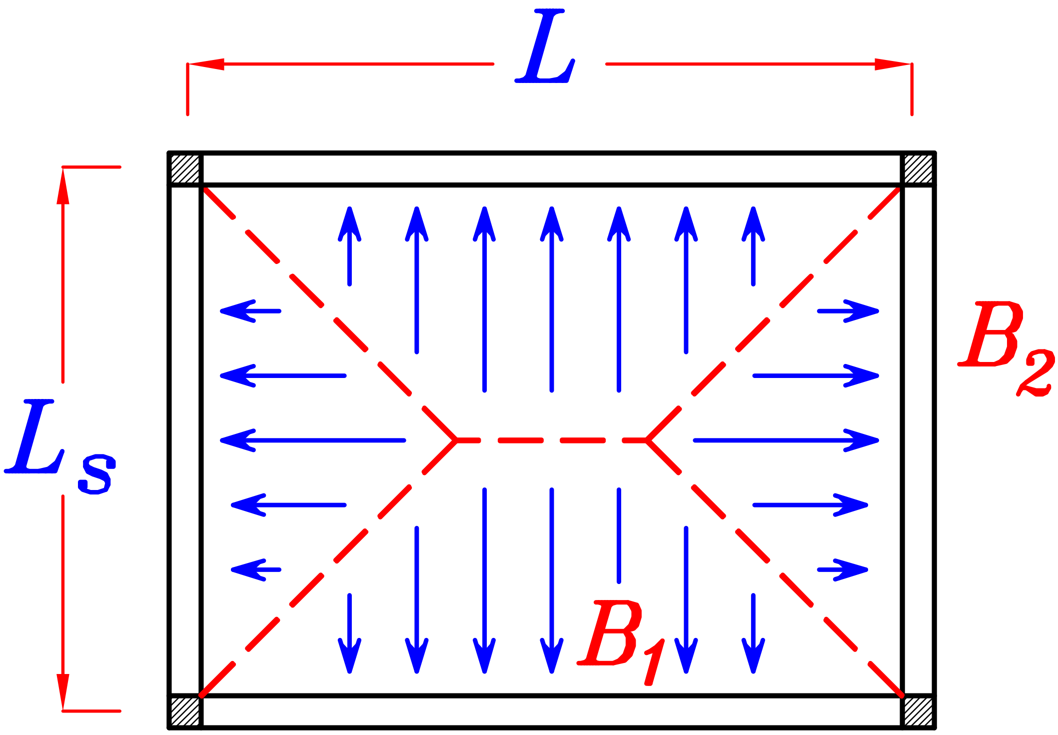
B2 الكمره لا تحمل أى شيئ من البلاطه

$$\boxed{w = o.w._{(beam)} + walls} \quad kN\backslash m'$$

B2



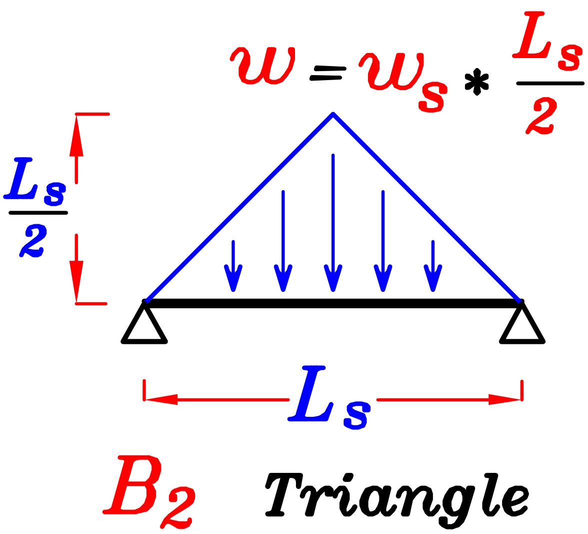
③ Two Way Slab.

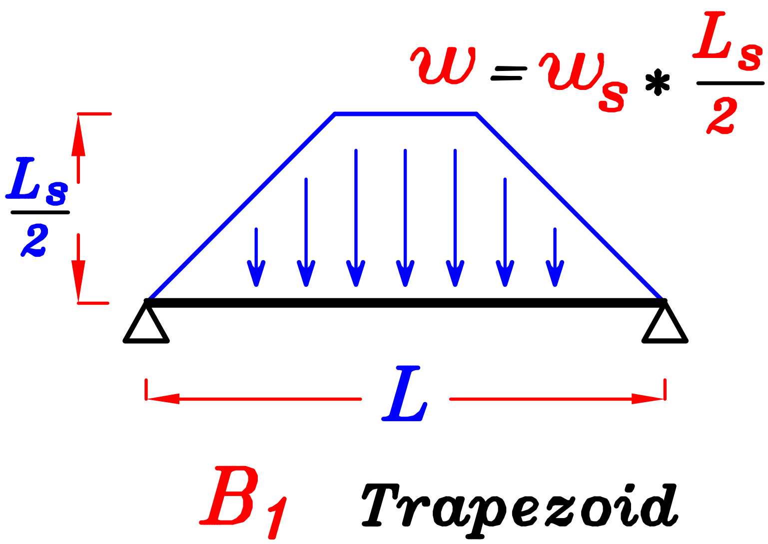


البلاطات الـ Two way تكون محموله على ٤ كمرات

و يجب أن يكون $\boxed{\frac{L}{L_s} \leqslant 2.0}$

و يذهب الحمل على شكل مثلث إلى الكمره القصيره .
و على شكل شبه منحرف إلى الكمره الطويله .





لان فى البلاطات الـ *Two way* يكون الحمل على الكمرات غير منتظم

فسيكون رسم الـ *B.M.D.* و الـ *S.F.D.* صعب جدا

و لاننا فى تصميم الكمرات نصمم على اكبر قيمه لل *moment* و اكبر قيمه لل *shear*

و لا نهتم بباقى شكل الـ *B.M.D.* و الـ *S.F.D.*

لذا سيتم حساب اكبر قيمه *moment* و اكبر قيمه لل *shear* عن طريق حمل تخيلى منتظم (لتسهيل الحسابات) و مكافىء للحمل الاصلى (اى سيكون اكبر قيمه *shear* له تساوى اكبر قيمه *shear* للشكل الاصلى و اكبر قيمه *moment* له تساوى اكبر قيمه *moment* للكل الاصلى)

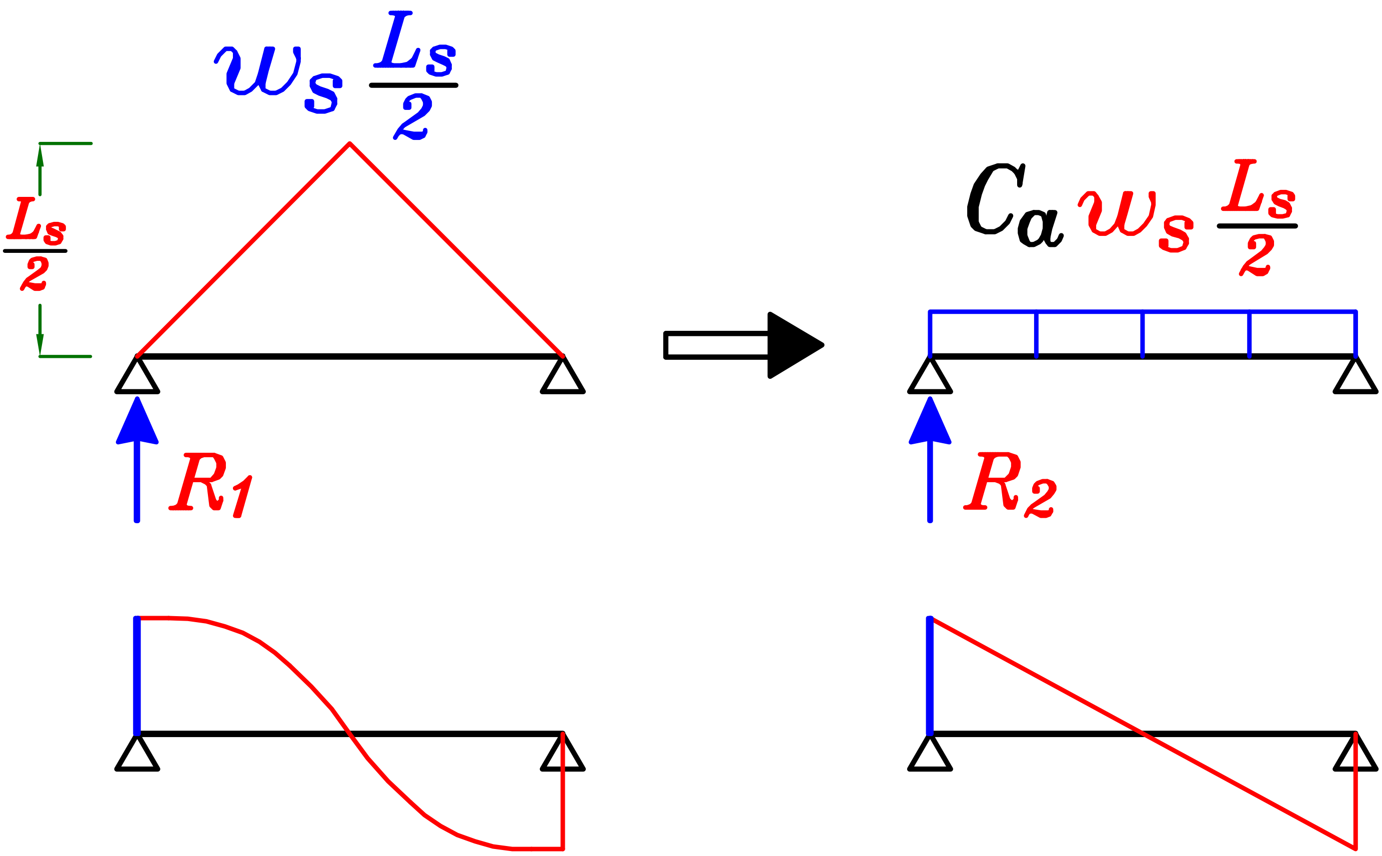
و ذلك باستخدام معامل C_a لتحديد اكبر قيمه لل *shear*

و معامل C_e لتحديد اكبر قيمه لل *moment*

---

* لتحديد قيم الـ C_a

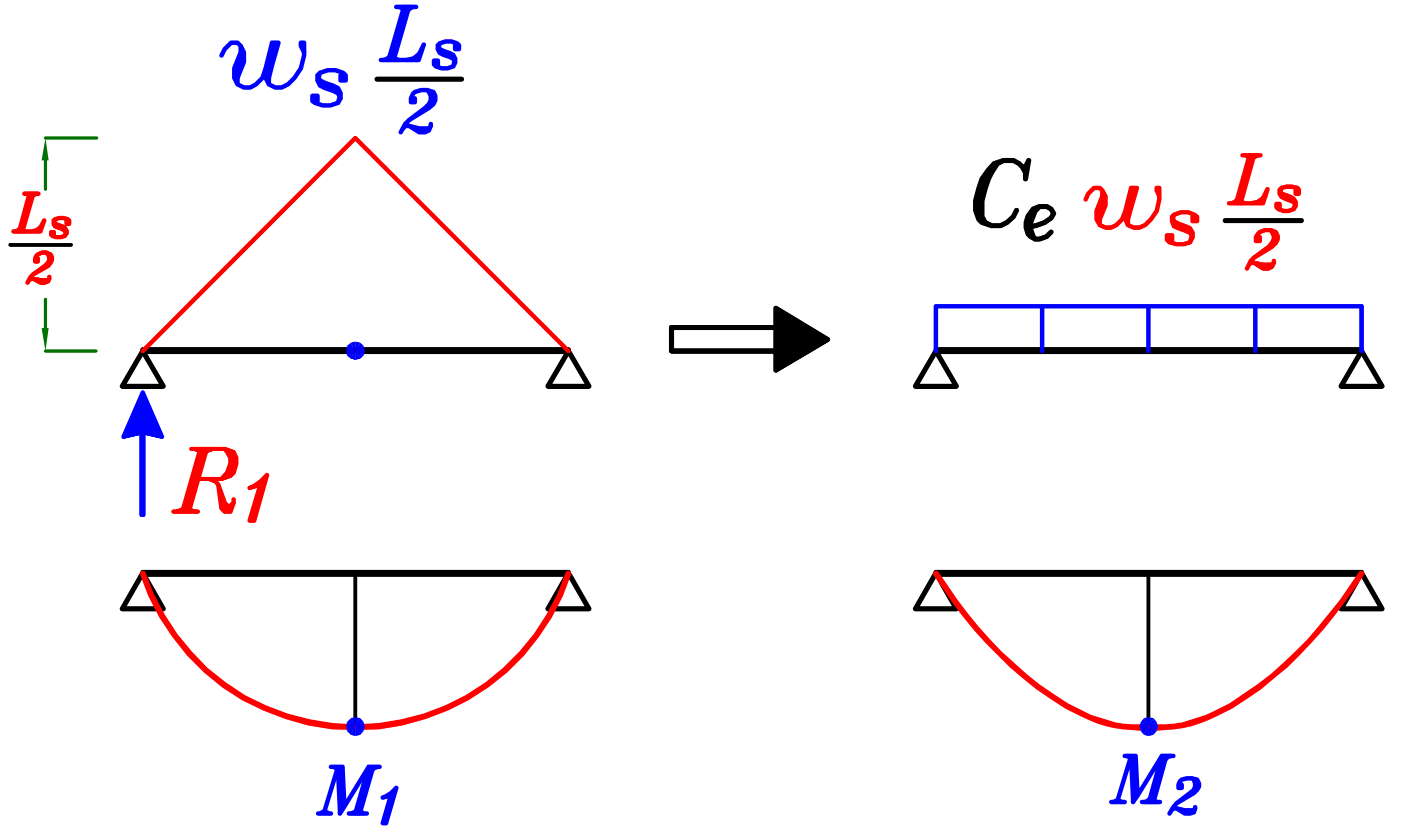
نساوى *Reaction* الحمل الاصلى R_1 بـ *Reaction* الحمل المكافىء R_2



$$\boxed{R_1 = R_2 \longrightarrow C_a = \checkmark}$$

* لتحديد قيم الـ C_e

نساوى moment الحمل الاصلى M_1 بـ moment الحمل المكافىء M_2



$$\boxed{M_1 = M_2 \longrightarrow C_e = \checkmark}$$

ملحوظه .

فى الكود المصرى قيمه C_a للـ Trapezoid تسمى β

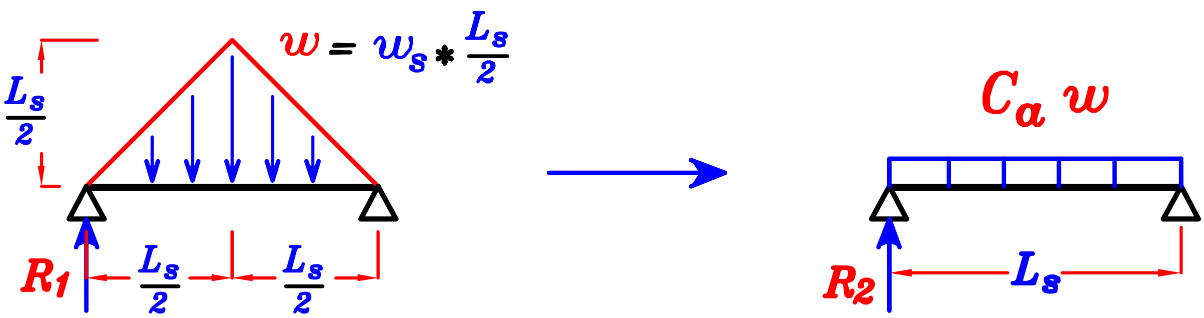
و قيمه C_e للـ Trapezoid تسمى α

Code Table (6–6)

$L \backslash L_s$	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
α	0.667	0.725	0.769	0.803	0.830	0.853	0.870	0.885	0.897	0.908	0.917
β	0.500	0.554	0.582	0.615	0.642	0.667	0.688	0.706	0.722	0.737	0.750

Triangular Load on Simple Span.

① Load For Shear.



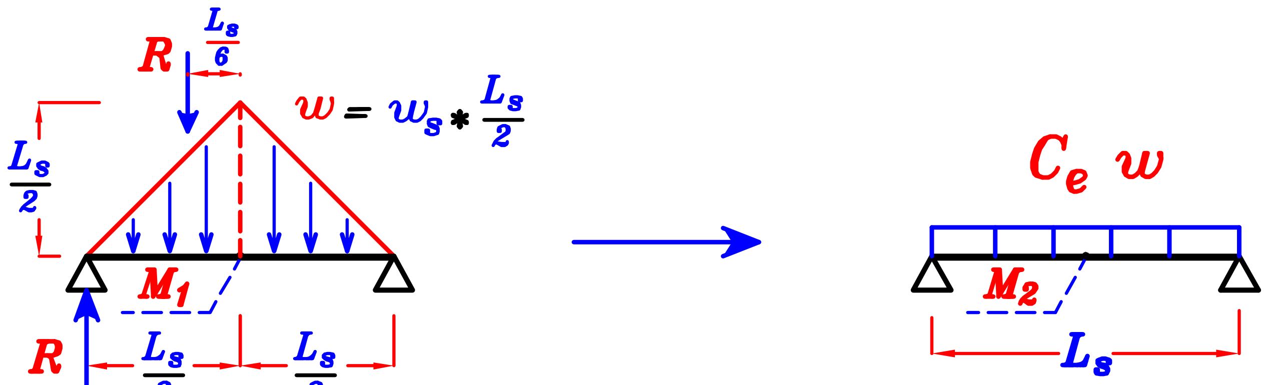
$$R_1 = \frac{\text{Total Load}}{2} = \frac{(1\backslash 2) * w * L_s}{2} = \frac{w * L_s}{4}$$

$$R_2 = \frac{(C_a * w) * L_s}{2}$$

$$\because R_1 = R_2 \quad \therefore \frac{\cancel{w} * \cancel{L_s}}{4} = \frac{(C_a * \cancel{w}) * \cancel{L_s}}{2} \longrightarrow \boxed{C_a = \frac{1}{2}}$$

---

② Load For Moment.



$$R = \frac{\text{Total Load}}{2} = \frac{(1\backslash 2) * w * L_s}{2} = \frac{w * L_s}{4}$$

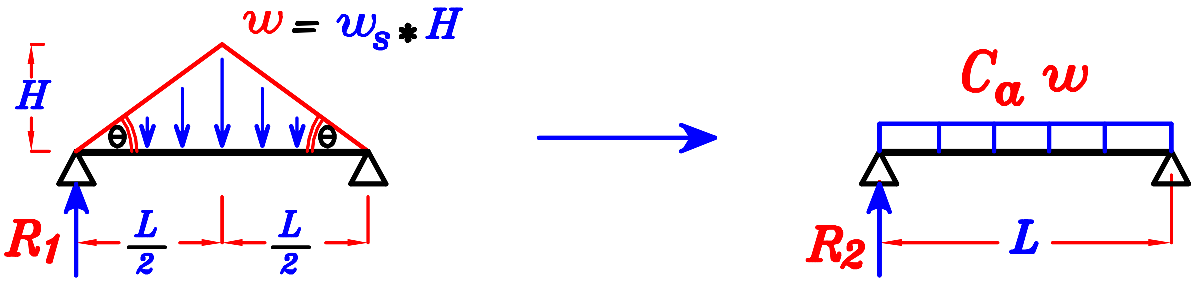
$$M_1 = R * \frac{L_s}{2} - R * \frac{L_s}{6} = R * \frac{L_s}{3} = \frac{w * L_s}{4} * \frac{L_s}{3} = \frac{w * L_s^2}{12}$$

$$M_2 = \frac{(C_e * w) * L_s^2}{8}$$

$$\because M_1 = M_2 \quad \therefore \frac{\cancel{w} * \cancel{L_s^2}}{12} = \frac{(C_e * \cancel{w}) * \cancel{L_s^2}}{8} \longrightarrow \boxed{C_e = \frac{2}{3}}$$

Triangular Load with equal angles.

① Load For Shear.

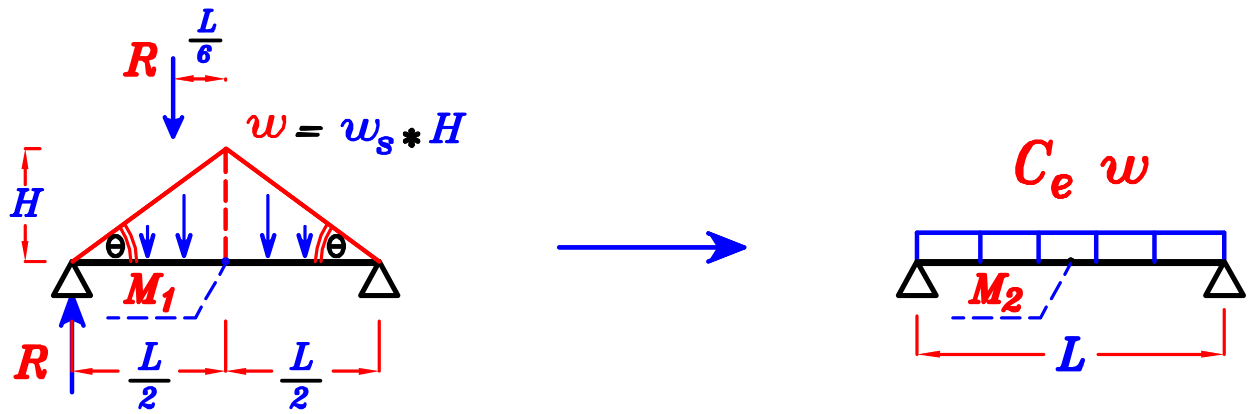


$$R_1 = \frac{\text{Total Load}}{2} = \frac{(1\backslash 2) * w * L}{2} = \frac{w * L}{4}$$

$$R_2 = \frac{(C_a * w) * L}{2}$$

$$\because R_1 = R_2 \quad \therefore \frac{\cancel{w} * \cancel{L}}{4} = \frac{(C_a * \cancel{w}) * \cancel{L}}{2} \longrightarrow \boxed{C_a = \frac{1}{2}}$$

② Load For Moment.



$$R = \frac{\text{Total Load}}{2} = \frac{(1\backslash 2) * w * L}{2} = \frac{w * L}{4}$$

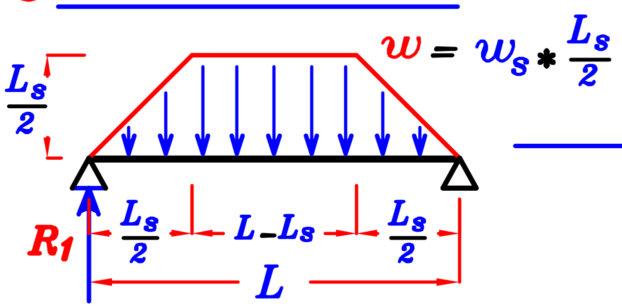
$$M_1 = R * \frac{L}{2} - R * \frac{L}{6} = R * \frac{L}{3} = \frac{w * L}{4} * \frac{L}{3} = \frac{w * L^2}{12}$$

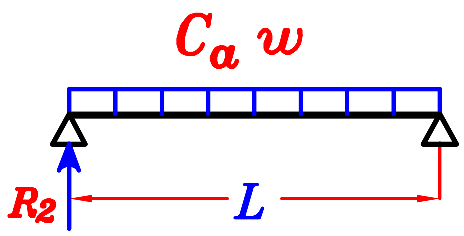
$$M_2 = \frac{(C_e * w) * L^2}{8}$$

$$\because M_1 = M_2 \quad \therefore \frac{\cancel{w} * \cancel{L}^2}{12} = \frac{(C_e * \cancel{w}) * \cancel{L}^2}{8} \longrightarrow \boxed{C_e = \frac{2}{3}}$$

Trapezoidal Load on Simple Span.

① Load For Shear.



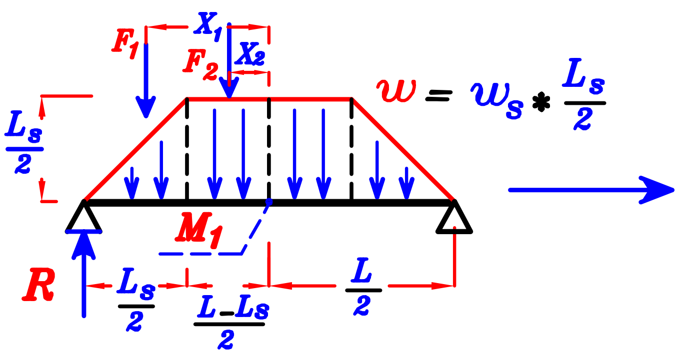


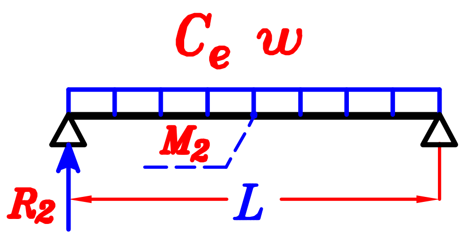
$$R_1 = (1\backslash 2)\ \text{Total Load} = (1\backslash 2)\left[\frac{L+(L-L_s)}{2}\right] w = \left(\frac{2L-L_s}{4}\right) w = \frac{wL}{2} - \frac{w\,L_s}{4}$$

$$R_2 = \frac{(C_a * w) * L}{2}$$

$$\because R_1 = R_2 \quad \therefore \frac{\cancel{w}\,L}{2} - \frac{\cancel{w}\,L_s}{4} = \frac{(C_a * \cancel{w}) * L}{2} \longrightarrow \boxed{C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right)}$$

② Load For Moment.





$$R = (1\backslash 2)\ \text{Total Load} = (1\backslash 2)\left[\frac{L+(L-L_s)}{2}\right] w = \left(\frac{2L-L_s}{4}\right) w = \frac{wL}{2} - \frac{w\,L_s}{4}$$

$$F_1 = (1\backslash 2) * w * \frac{L_s}{2} = \frac{w * L_s}{4} \quad , \quad X_1 = \frac{L-L_s}{2} + \frac{L_s}{6} = \frac{L}{2} - \frac{L_s}{3}$$

$$F_2 = w\left(\frac{L-L_s}{2}\right) = \frac{wL}{2} - \frac{w\,L_s}{2} \quad , \quad X_2 = \frac{L-L_s}{4} = \frac{L}{4} - \frac{L_s}{4}$$

$$M_1 = R * \frac{L}{2} - F_1 * X_1 - F_2 * X_2$$

$$M_1 = \left(\frac{wL}{2} - \frac{w\,L_s}{4}\right) * \frac{L}{2} - \left(\frac{w * L_s}{4}\right)\left(\frac{L}{2} - \frac{L_s}{3}\right) - \left(\frac{wL}{2} - \frac{w\,L_s}{2}\right)\left(\frac{L}{4} - \frac{L_s}{4}\right)$$

$$= \frac{w\,L^2}{4} - \frac{w\,L\,L_s}{8} - \frac{w\,L\,L_s}{8} + \frac{w\,L_s^2}{12} - \frac{w\,L^2}{8} + \frac{w\,L\,L_s}{8} + \frac{w\,L\,L_s}{8} - \frac{w\,L_s^2}{8}$$

$$= \left(\frac{wL^2}{4} - \frac{wL^2}{8}\right) + \left(\frac{w\,L_s^2}{12} - \frac{w\,L_s^2}{8}\right) = \frac{wL^2}{8} - \frac{w\,L_s^2}{24}$$

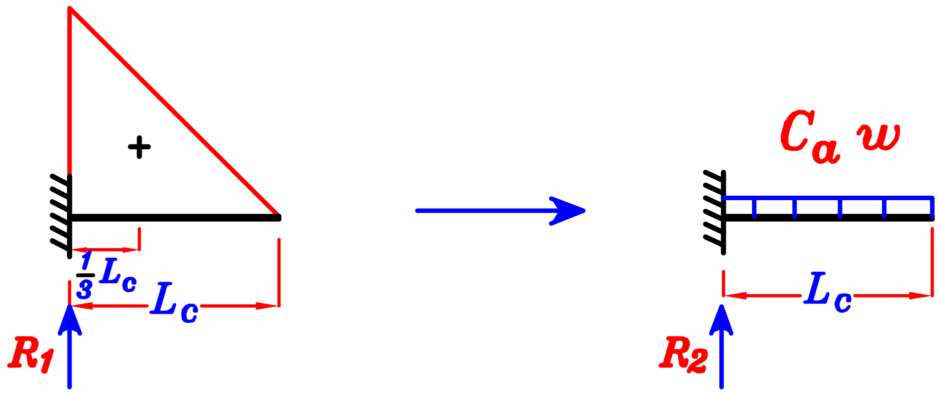
$$\because M_1 = M_2 \quad \therefore \frac{\cancel{w}L^2}{8} - \frac{\cancel{w}\,L_s^2}{24} = \frac{(C_e * \cancel{w}) * L^2}{8} \qquad \therefore L^2 - \frac{L_s^2}{3} = C_e * L^2$$

Divide by (L^2) $\therefore$ $\boxed{C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2}$

Triangular Load on Cantilever.

① Load For Shear.

$w = w_s * L_c$



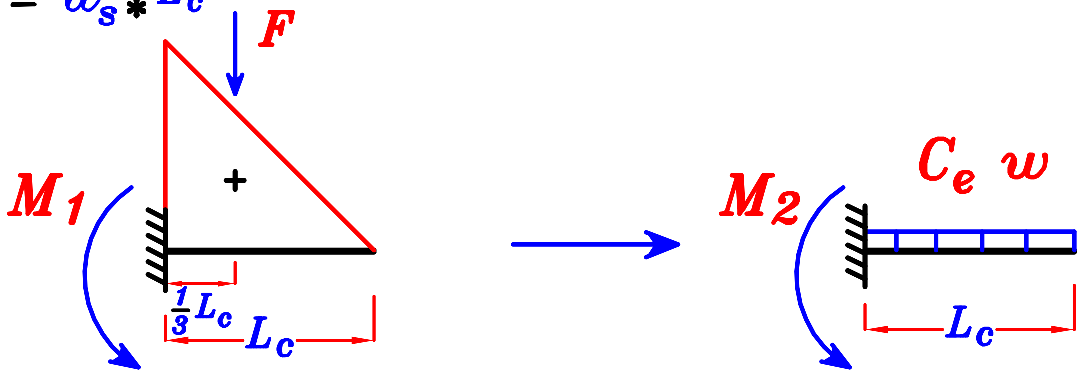
$$R_1 = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

$$R_2 = (C_a * w) * L_c$$

$$\because R_1 = R_2 \quad \therefore \frac{\cancel{w} * \cancel{L_c}}{2} = (C_a * \cancel{w}) * \cancel{L_c} \longrightarrow \boxed{C_a = \frac{1}{2}}$$

② Load For Moment.

$w = w_s * L_c$



$$F = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

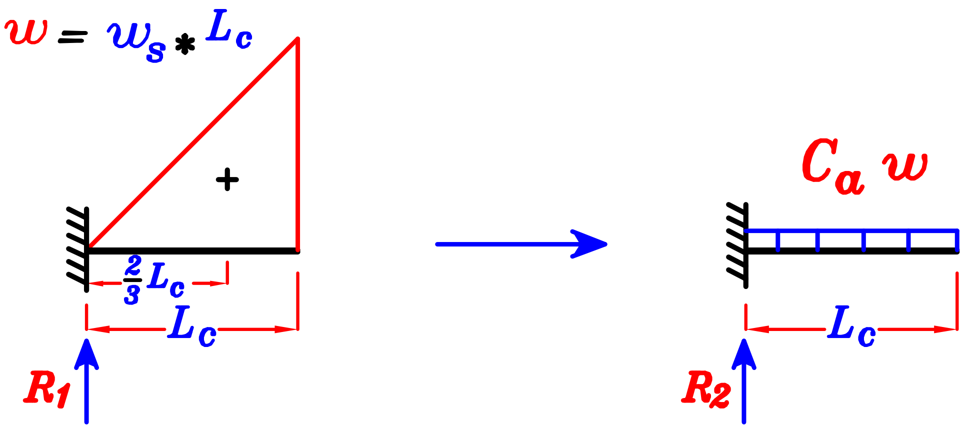
$$M_1 = F * \frac{1}{3} L_c = \frac{w * L_c}{2} * \frac{1}{3} L_c = \frac{w * L_c^2}{6}$$

$$M_2 = \frac{(C_e * w) * L_c^2}{2}$$

$$\because M_1 = M_2 \quad \therefore \frac{w * L_c^2}{6} = \frac{(C_e * w) * L_c^2}{2} \longrightarrow \boxed{C_e = \frac{1}{3}}$$

Triangular Load on Cantilever.

① Load For Shear.

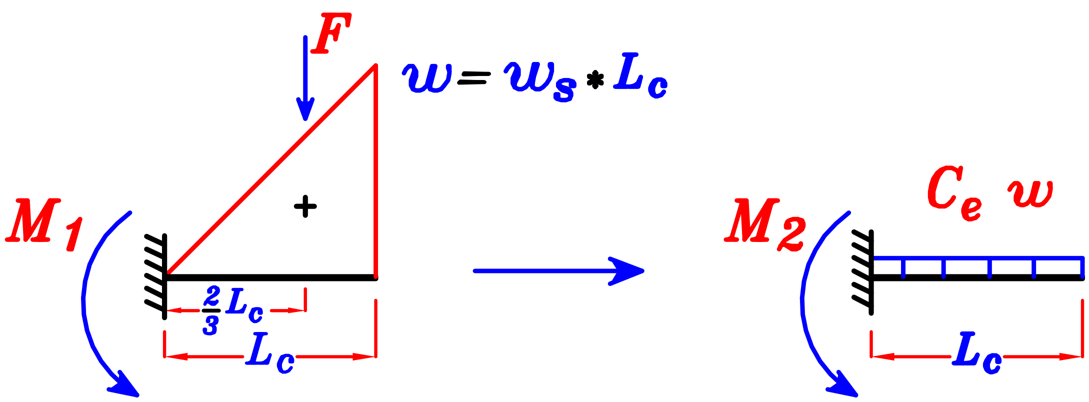


$$R_1 = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

$$R_2 = (C_a * w) * L_c$$

$$\because R_1 = R_2 \qquad \therefore \frac{\cancel{w} * \cancel{L_c}}{2} = (C_a * \cancel{w}) * \cancel{L_c} \longrightarrow \boxed{C_a = \frac{1}{2}}$$

② Load For Moment.



$$F = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

$$M_1 = F * \frac{2}{3} L_c = \frac{w * L_c}{2} * \frac{2}{3} L_c = \frac{w * L_c^2}{3}$$

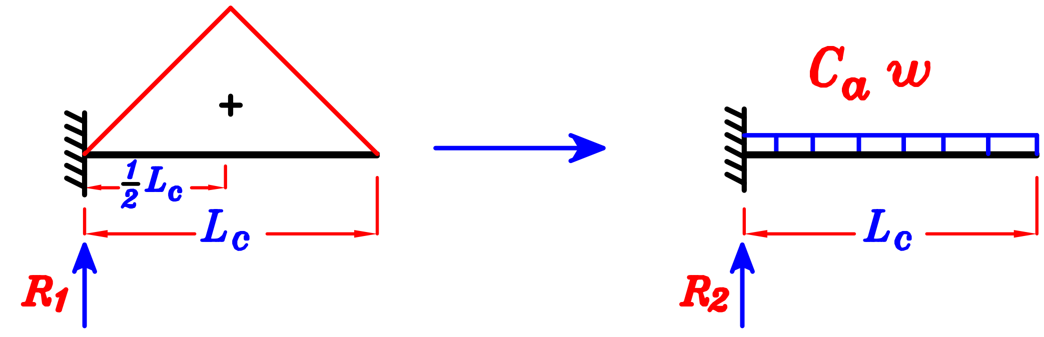
$$M_2 = \frac{(C_e * w) * L_c^2}{2}$$

$$\because M_1 = M_2 \qquad \therefore \frac{w * L_c^2}{3} = \frac{(C_e * w) * L_c^2}{2} \longrightarrow \boxed{C_e = \frac{2}{3}}$$

Triangular Load on Cantilever.

① Load For Shear.

$$w = w_s * \frac{L_c}{2}$$



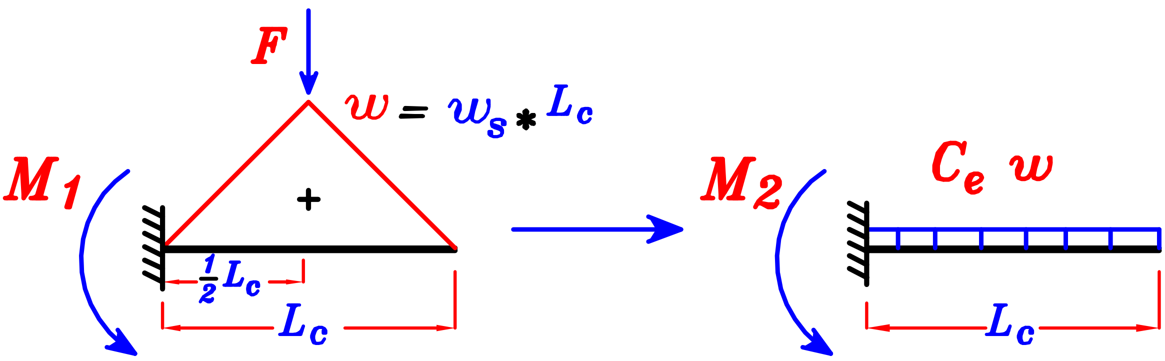
$$R_1 = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

$$R_2 = (C_a * w) * L_c$$

$$\because R_1 = R_2 \quad \therefore \frac{\cancel{w} * \cancel{L_c}}{2} = (C_a * \cancel{w}) * \cancel{L_c} \longrightarrow \boxed{C_a = \frac{1}{2}}$$

② Load For Moment.

$$w = w_s * L_c$$



$$F = \text{Total Load} = (1\backslash 2) * w * L_c = \frac{w * L_c}{2}$$

$$M_1 = F * \frac{1}{2} L_c = \frac{w * L_c}{2} * \frac{1}{2} L_c = \frac{w * L_c^2}{4}$$

$$M_2 = \frac{(C_e * w) * L_c^2}{2}$$

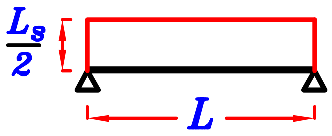
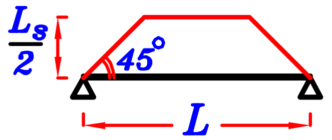
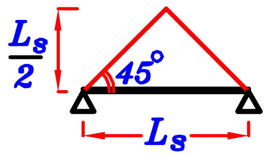
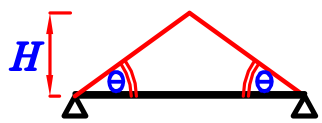
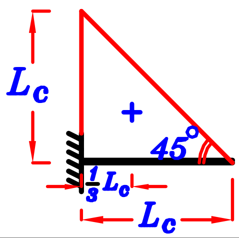
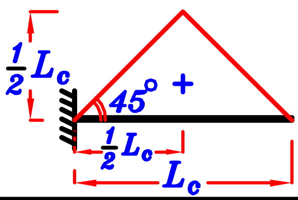
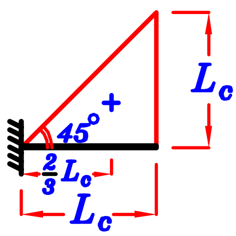
$$\because M_1 = M_2 \quad \therefore \frac{w * L_c^2}{4} = \frac{(C_e * w) * L_c^2}{2} \longrightarrow \boxed{C_e = \frac{1}{2}}$$

Equivalent Load Form Slab. =

Factor * w_s * (Max. Load Height)

Where that Factor $C_a \longrightarrow$ **For Shear.**

$C_e \longrightarrow$ **For Moment.**

Shape of Load	C_a	C_e	Equivalent Load From the Slab
	1.0	1.0	$w_s \frac{L_s}{2}$
	$1-\frac{1}{2}\left(\frac{L_s}{L}\right)$	$1-\frac{1}{3}\left(\frac{L_s}{L}\right)^2$	$C_a\ w_s \frac{L_s}{2}$ $C_e\ w_s \frac{L_s}{2}$
	$\frac{1}{2}$	$\frac{2}{3}$	$C_a\ w_s \frac{L_s}{2}$ $C_e\ w_s \frac{L_s}{2}$
	$\frac{1}{2}$	$\frac{2}{3}$	$C_a\ w_s\ H$ $C_e\ w_s\ H$
	$\frac{1}{2}$	$\frac{1}{3}$	$C_a\ w_s\ L_c$ $C_e\ w_s\ L_c$
	$\frac{1}{2}$	$\frac{1}{2}$	$C_a\ w_s \frac{L_c}{2}$ $C_e\ w_s \frac{L_c}{2}$
	$\frac{1}{2}$	$\frac{2}{3}$	$C_a\ w_s\ L_c$ $C_e\ w_s\ L_c$
Any Other Shape	———	———	$\frac{\sum area}{Span} * w_s$

C_a , C_e هى **Factors** تستخدم فقط تحت عده شروط :

١- أن يكون كل الحمل بين ال **2 Supports** بأكملهم .

٢- أن يكون شكل الحمل كما فى الأشكال السابقة فى الجدول .

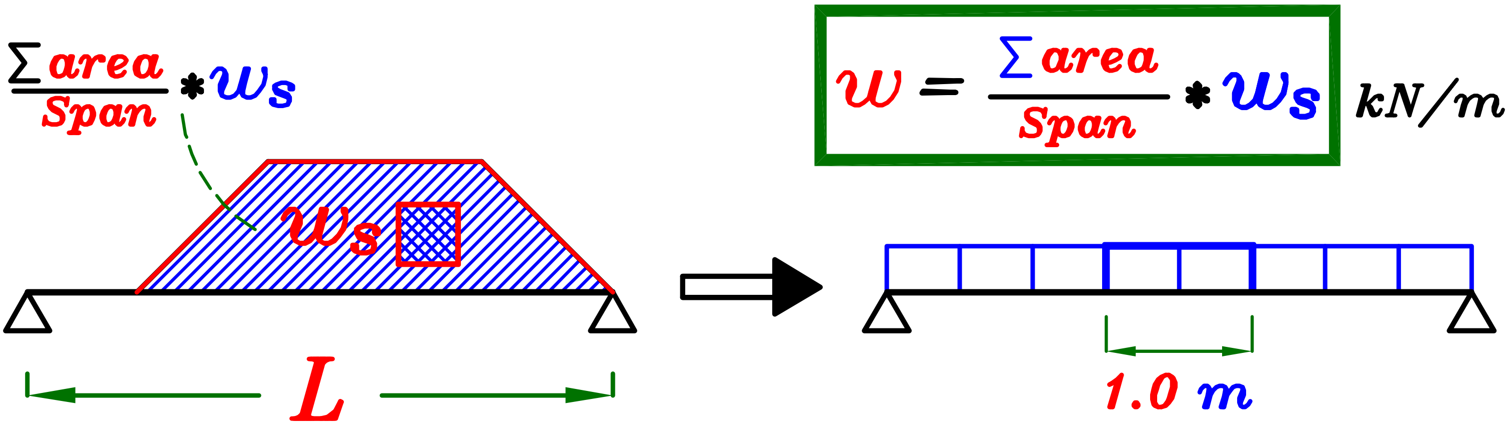
و إذا لم تتوافر هذه الشروط نستخدم طريقه تقريبيه تسمى $\frac{\sum area}{span}$

Where the equivalent load From the slab $= \frac{\sum area}{span} * w_s = \checkmark$ kN\m`

$$\boxed{w = \frac{\sum area}{span} * w_s = \checkmark \; kN\backslash m`}$$

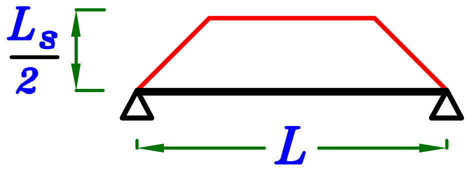
حيث $\sum area$ هو مجموع مساحات الأحمال الواقعه بين ال **2 Supports**

و ال **span** هى المسافه بين ال **2 Supports** .



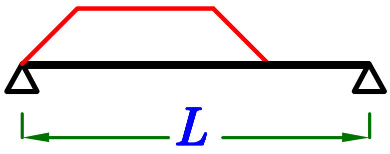
Example.

Get Loads on the beams at the Following cases.



use C_a , C_e

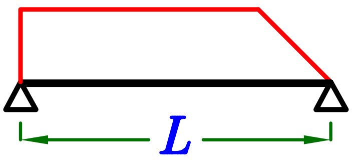
$$w = O.W. + walls + C_a\, w_s \frac{L_s}{2}$$



(The load is not Covering all the span)

$\therefore$ use $\frac{\sum area}{span}$

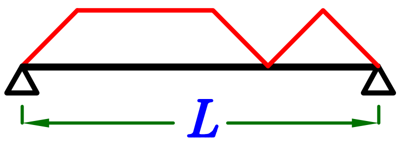
$$\therefore w = O.W. + walls + \frac{\sum area}{L} * w_s$$



(The shape isn't one of the table shapes)

$\therefore$ use $\frac{\sum area}{span}$

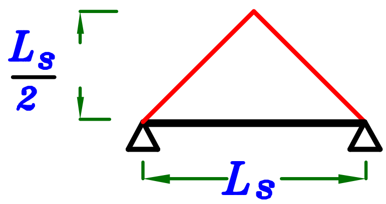
$$\therefore w = O.W. + walls + \frac{\sum area}{L} * w_s$$



(Non of the shapes is covering the whole span)

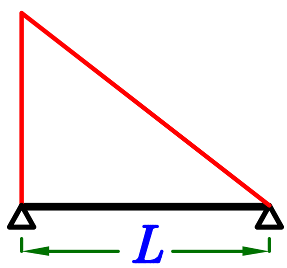
$\therefore$ use $\frac{\sum area}{span}$

$$\therefore w = O.W. + walls + \frac{\sum area}{L} * w_s$$



use C_a , C_e

$$w = O.W. + walls + C_a\, w_s \frac{L_s}{2}$$



(The shape isn't one of the table shapes)

$\therefore$ use $\frac{\sum area}{span}$

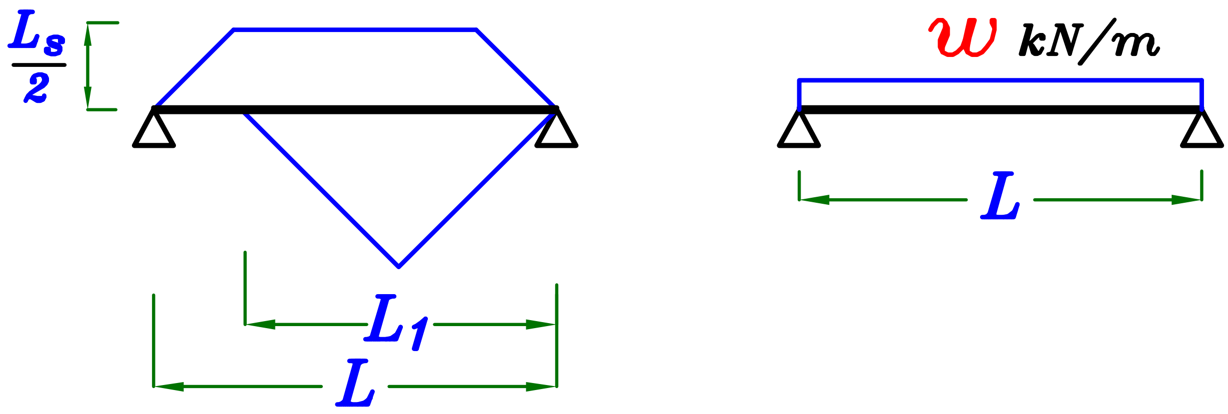
$$\therefore w = O.W. + walls + \frac{\sum area}{L} * w_s$$

Notes.

عند وجود أكثر من حمل على الكمره نحسب كل حمل بمفرده w_1 , w_2

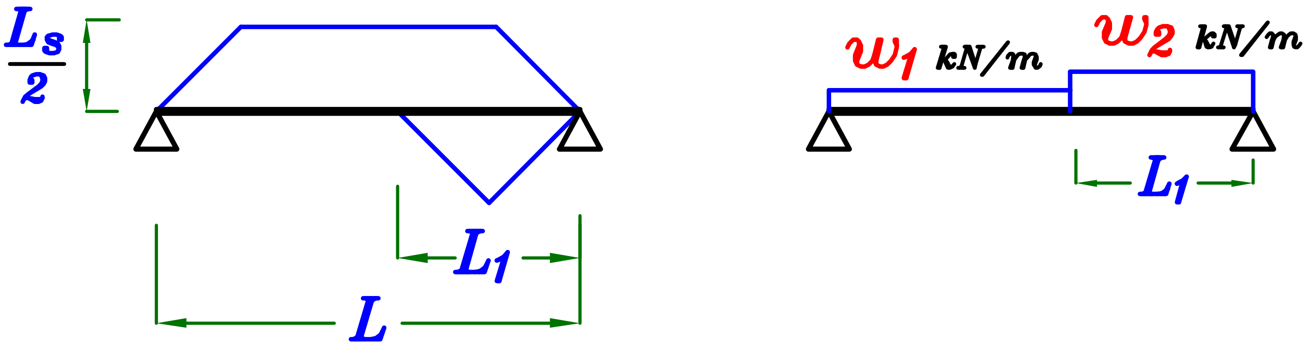
و هناك حالتان :

① IF $L_1 \geqslant \frac{L}{2}$



$$w = o.w. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{L} * w_s$$

② IF $L_1 < \frac{L}{2}$

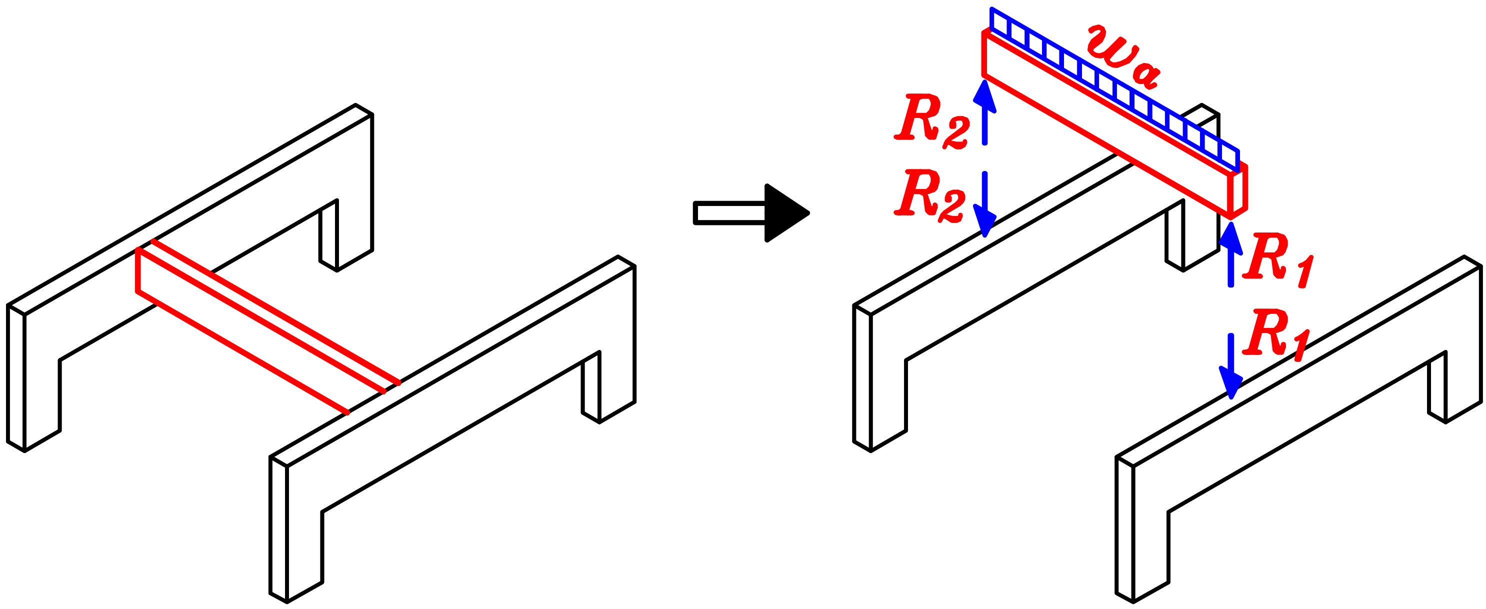


$$w_1 = o.w. + C_a\, w_s \frac{L_s}{2}$$

$$w_2 = o.w. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{L_1} * w_s$$

ملحوظه :

عند وجود كمره محموله على كمره أخرى .



يجب أولاً أن نحسب الأحمال على الكمره المحموله و نحدد لها ال ***Reaction***
عن طريق ال ***Load For Shear*** أى بأستخدام C_a
و بعد تحديد ال ***Reaction*** يُعكس على الكمره الاخرى (الحامله) .

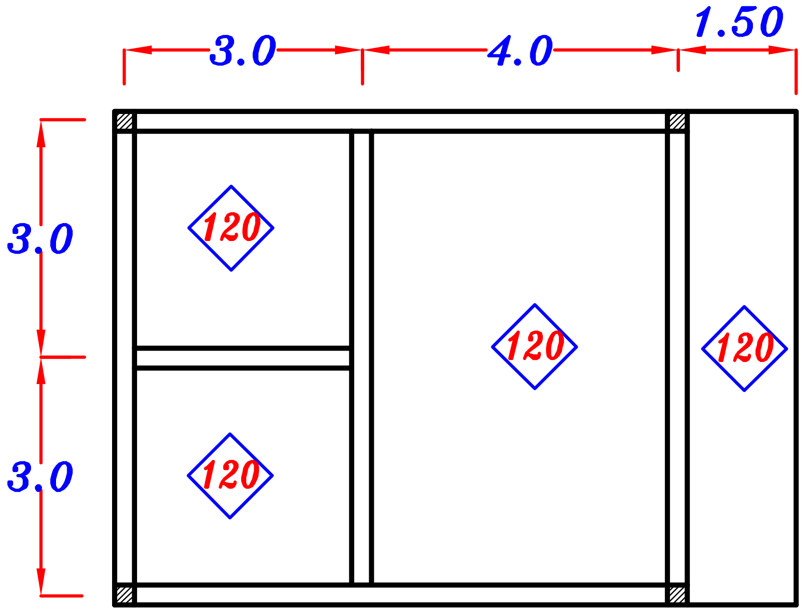
Example.

$t_s = 120\ mm$

$F.C. = 1.50\ kN\backslash m^2$

$L.L. = 2.0\ kN\backslash m^2$

$O.W.$ of beams $= 3.0\ kN\backslash m'$



Req.

Draw S.F.D. & B.M.D. For all beams.

خطوات مسأله Load Distribution

١- نرسم الـ *Plan* يفضل بمقياس رسم ١ : ١٠٠

٢- نرسم خطوط توزيع الـ *Loads* (*Load Distribution*)

٣- نسمى الكمرات ...... B_3 , B_2 , B_1 و نسمى الكمرات المحمولة اولا .

٤- نحسب w_s

نحسب *o.w.* الكمرات اذا لم تكن معطاه .

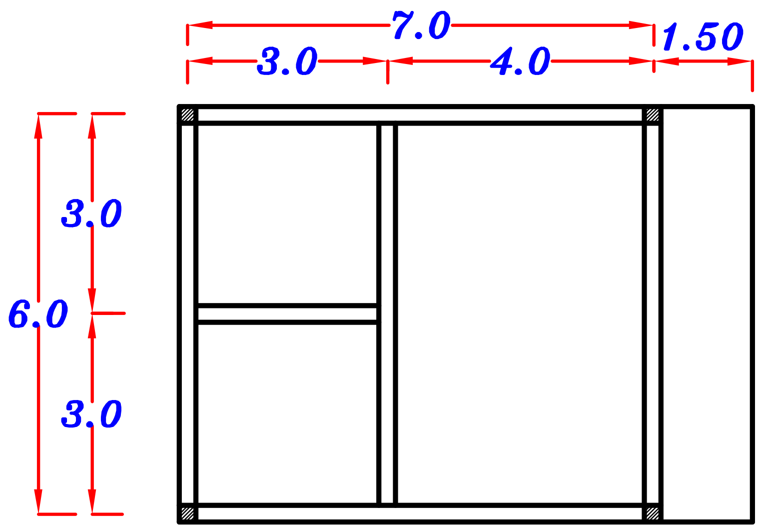
نحسب وزن الحوائط ان وجدت .

٥- نرسم *B.M.D. & S.F.D.* للـ *Beams*

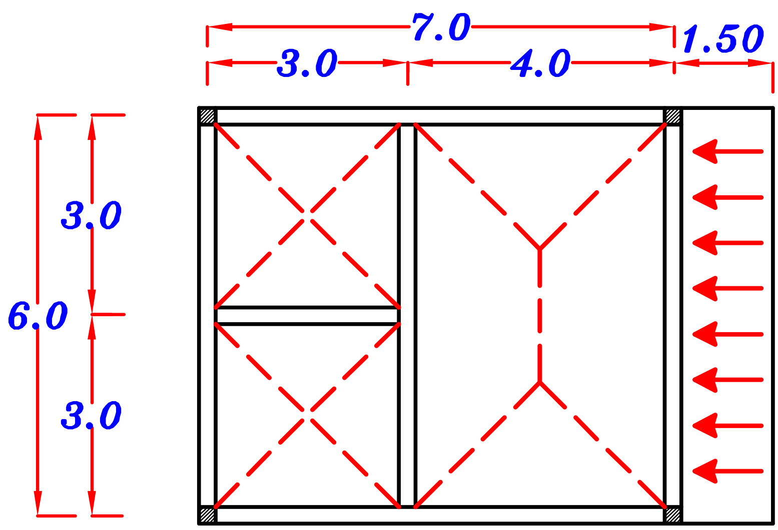
(الكمرات المحمولة اولا ثم الكمرات الحاملة)

Solution.

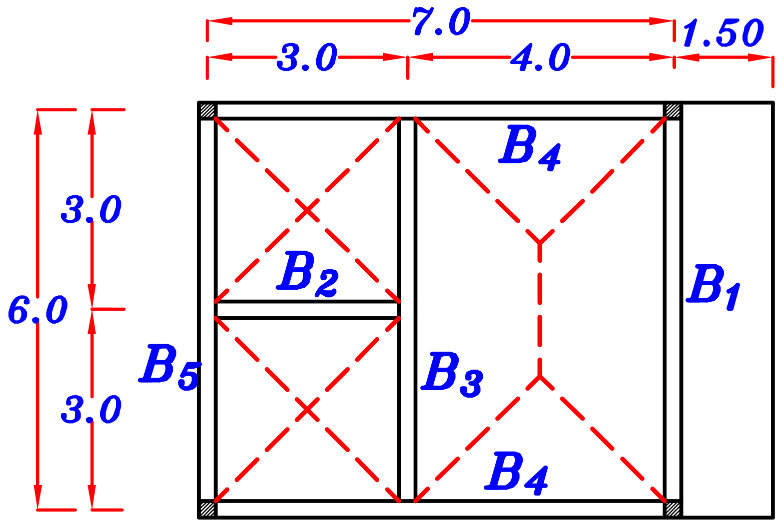
١- نرسم الـ ***Plan*** يفضل بمقياس رسم ١ : ١٠٠



٢- نرسم خطوط توزيع الـ ***Loads*** (***Load Distribution***)



٣- نسمى الكمرات ...... B_1 , B_2 , B_3 و نسمى الكمرات المحموله اولا .



٤ - نحسب w_s

نحسب $o.w.$ الكمرات اذا لم تكن معطاه .

نحسب وزن الحوائط ان وجدت .

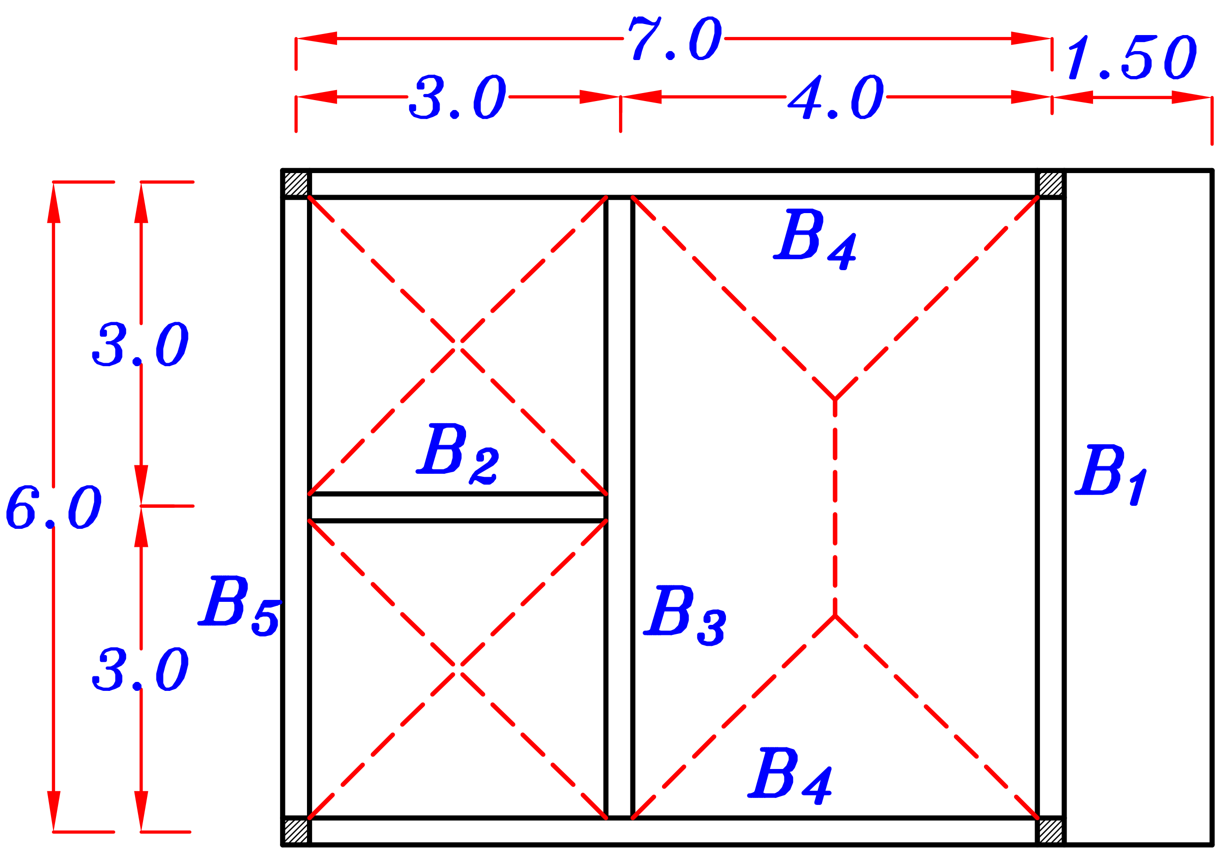
$$w_s = g_s + p_s = (t_s * \gamma_c + F.C.) + L.L.$$

$$= (0.12 * 25 + 1.50) + 2.0 = 6.50 \ kN\backslash m^2$$

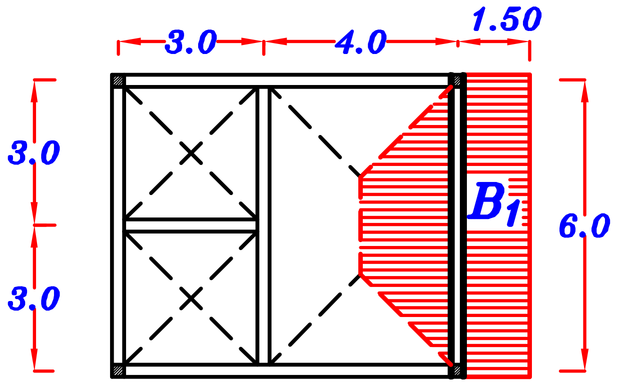
$$\boxed{w_s = 6.50 \ kN\backslash m^2}$$

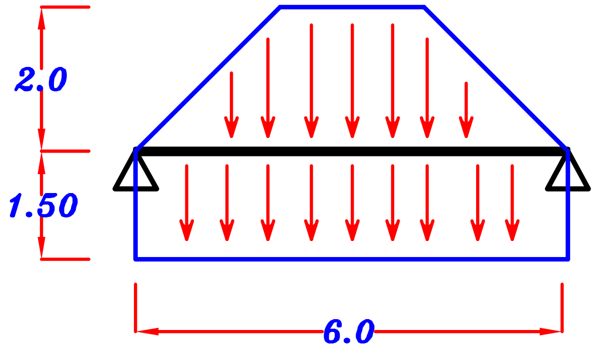
$o.w.$ of beams $= 3.0$ kN\m\` (as given in data)

$o.w.$ of walls $=$ Zero (because it is not given in data)



B_1





For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{6}\right) = \frac{2}{3}$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4}{6}\right)^2 = 0.85$$

For Rectangle $C_a = C_e = 1$

Load For Shear w_a

$$w_a = o.w. + w_s L_c + C_a w_s \frac{L_s}{2}$$

$$= 3.0 + (6.50)(1.5) + \frac{2}{3}(6.50)\left(\frac{4}{2}\right) = 21.42 \text{ kN\m`}$$

Load For moment w_e

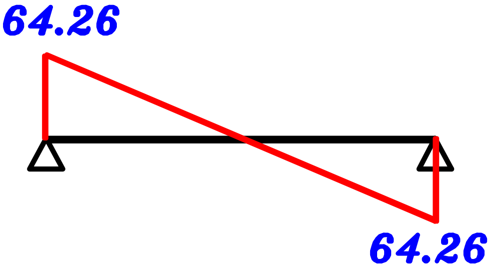
$$w_e = o.w. + w_s L_c + C_e w_s \frac{L_s}{2}$$

$$= 3.0 + (6.50)(1.5) + (0.85)(6.50)\left(\frac{4}{2}\right) = 23.80 \text{ kN\m`}$$

Load For Shear

$w_a = 21.42$ kN\m`

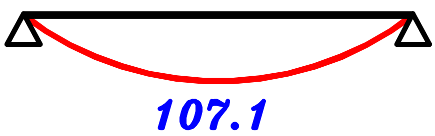
S.F.D.



Load For Moment

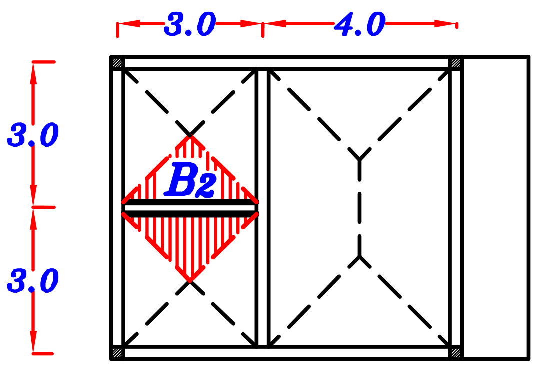
$w_e = 23.80$ kN\m`

B.M.D.



B_2

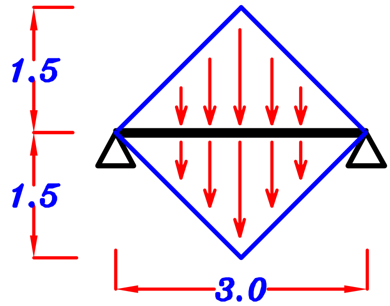
For Triangle $C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$



Load For Shear w_a

$$w_a = O.W. + 2\left(C_a\, w_s\, \frac{L_s}{2}\right)$$

$$= 3.0 + 2\left(\frac{1}{2}(6.50)(\frac{3}{2})\right) = 12.75 \text{ kN\textbackslash m`}$$



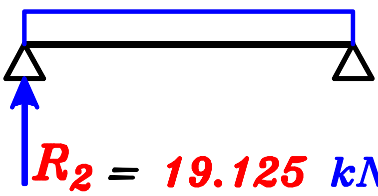
Load For moment w_e

$$w_e = O.W. + 2\left(C_e\, w_s\, \frac{L_s}{2}\right)$$

$$= 3.0 + 2\left(\frac{2}{3}(6.50)(\frac{3}{2})\right) = 16.0 \text{ kN\textbackslash m`}$$

Load For Shear

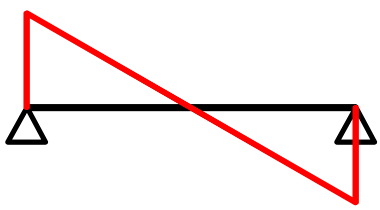
12.75 kN\m`



$R_2 = 19.125$ kN

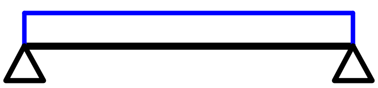
will be reversed on B_3 , B_5

S.F.D.

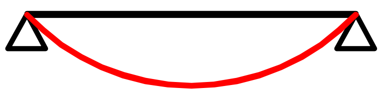


Load For Moment

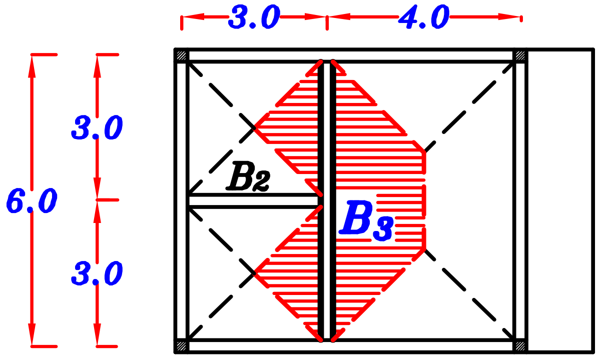
16.0 kN\m`



B.M.D.



B_3



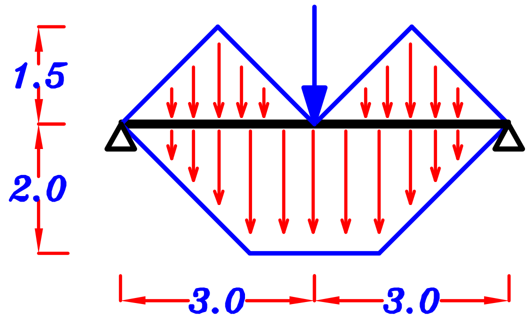
For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{6}\right) = \frac{2}{3}$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4}{6}\right)^2 = 0.85$$

For Triangles

$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(3)(1.5)\right)}{6} = 0.75$$



Load For Shear w_a

$$w_a = 0.W. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{span} * w_s$$

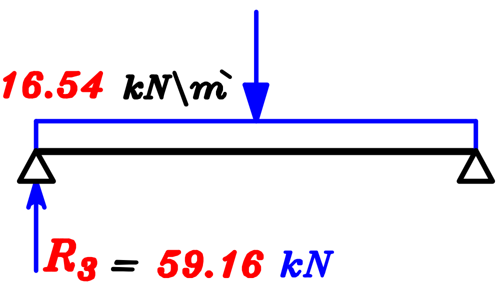
$$w_a = 3.0 + \frac{2}{3}(6.50)\left(\frac{4}{2}\right) + 0.75\,(6.50) = 16.54 \ kN\backslash m`$$

Load For moment w_e

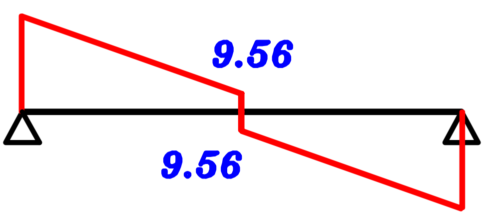
$$w_e = 0.W. + C_e\, w_s \frac{L_s}{2} + \frac{\sum area}{span} * w_s$$

$$w_e = 3.0 + (0.85)(6.50)\left(\frac{4}{2}\right) + 0.75\,(6.50) = 18.925 \ kN\backslash m`$$

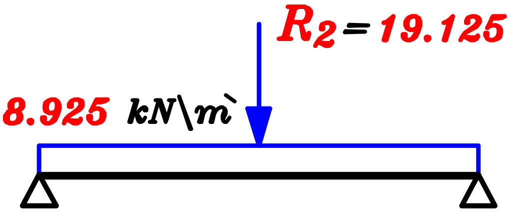
Load For Shear



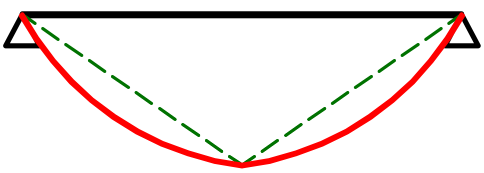
S.F.D.



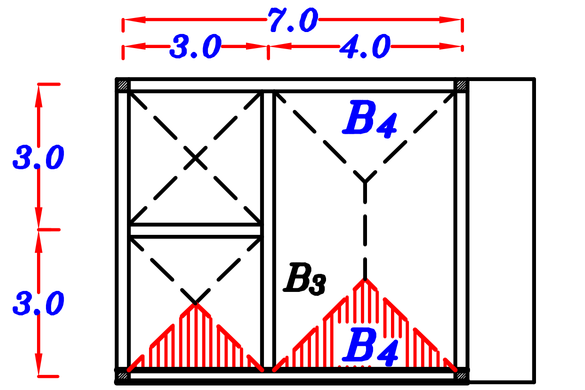
Load For Moment



B.M.D.

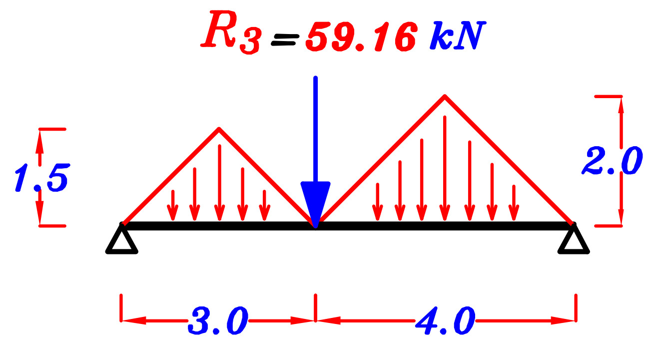


B_4



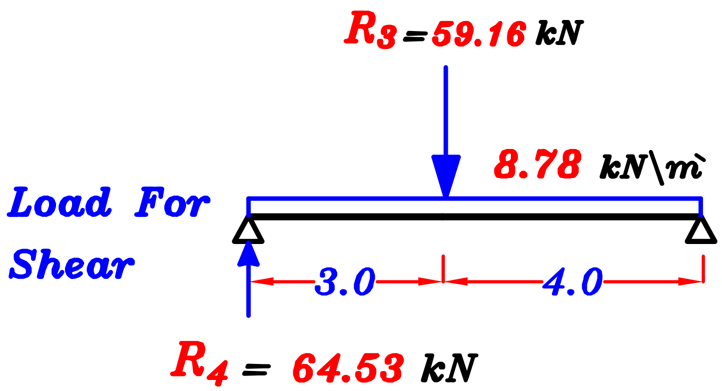
For Triangles

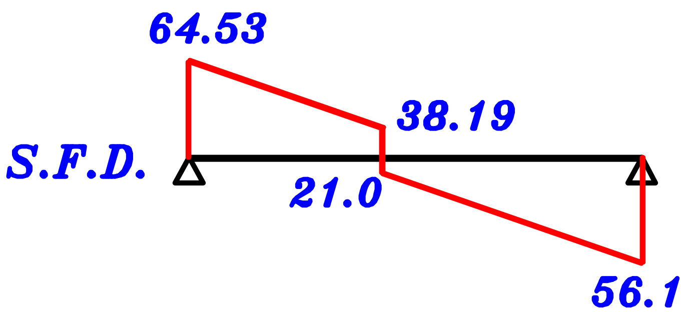
$$\frac{\sum area}{span} = \frac{\frac{1}{2}(3)(1.5)+\frac{1}{2}(4)(2)}{7.0} = 0.89$$

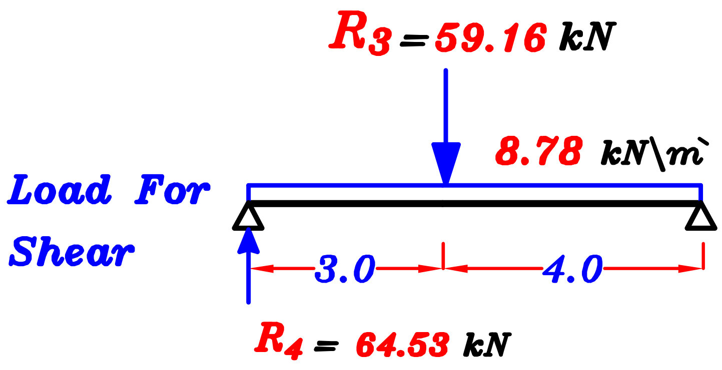


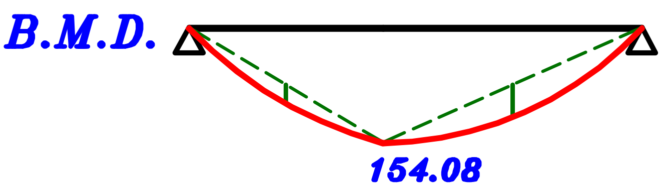
Load For Shear = Load For moment

$$w_a = w_e = O.W. + \frac{\sum area}{span} * w_s = 3.0 + 0.89\,(6.50) = 8.78 \text{ kN}\backslash m`$$

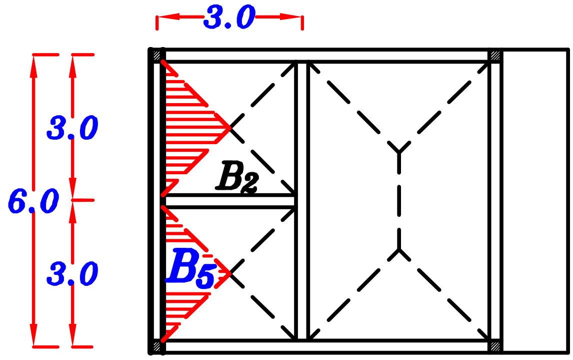






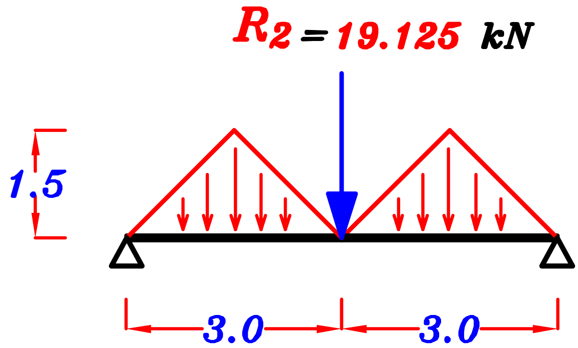


B_5



For Triangles

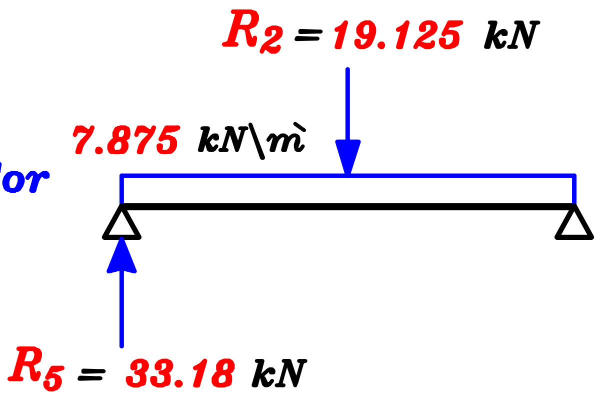
$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(3)\,(1.5)\right)}{6} = 0.75$$



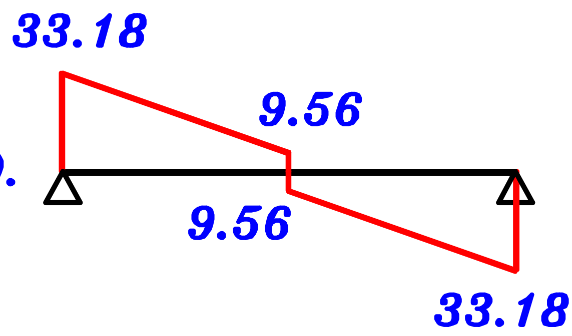
Load For Shear = Load For moment

$$w_a = w_e = O.W. + \overset{\triangle\triangle}{\frac{\sum area}{span}} * w_s = 3.0 + 0.75\ (6.50) = 7.875\ kN\backslash m`$$

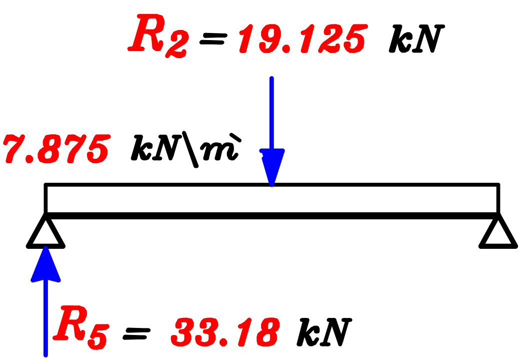
Load For Shear



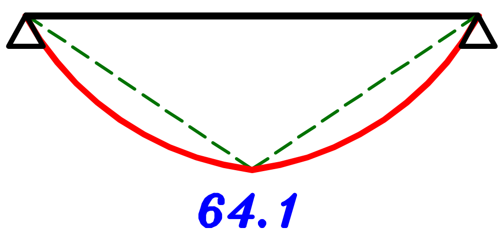
S.F.D.



Load For Moment



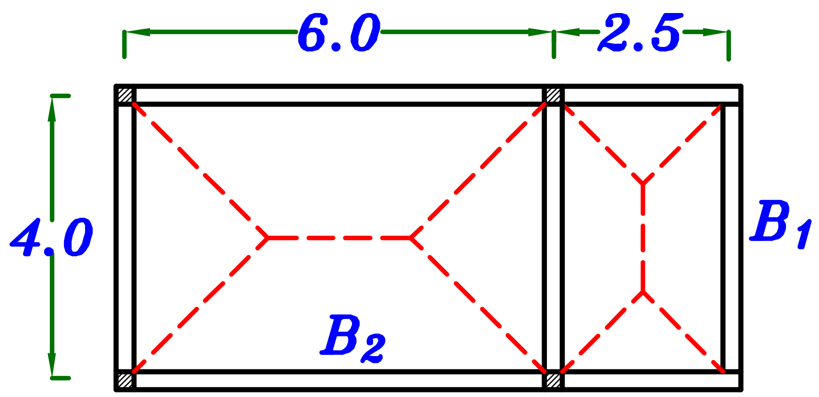
B.M.D.



Beams with more than one span.

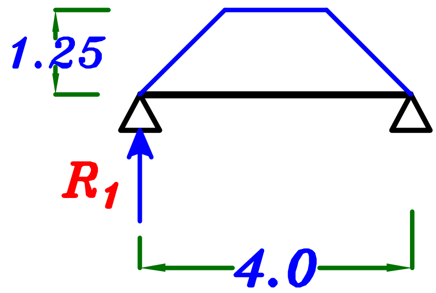
قاعدة هامه عند حساب الاحمال على كمره بها أكثر من span
يتم حساب ال w لكل span على حده

Example.



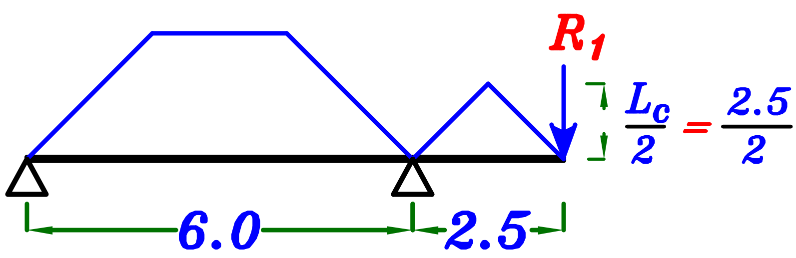
B_1

$$w = O.W. + \frac{C_a}{C_e}\, w_s\, \frac{L_s}{2}$$

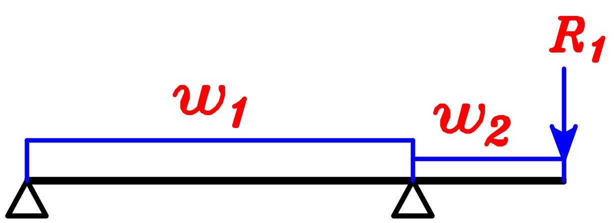


B_2

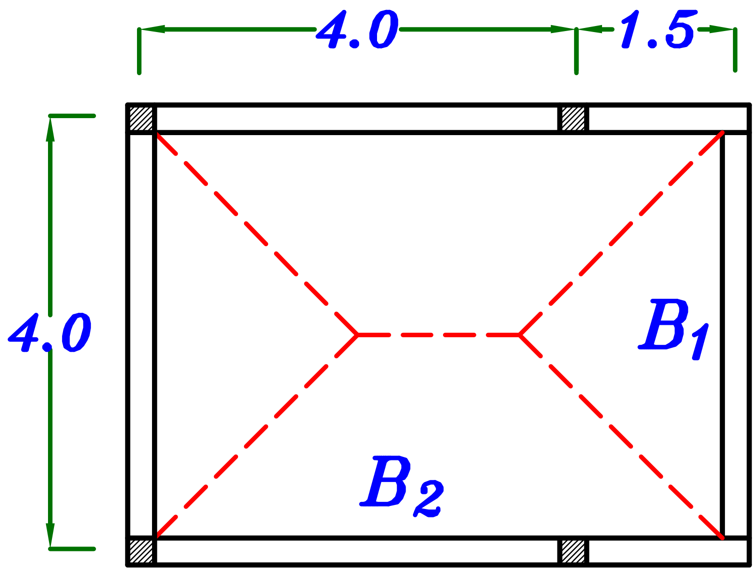
$$w_1 = O.W. + \frac{C_a}{C_e}\, w_s\, \frac{L_s}{2}$$



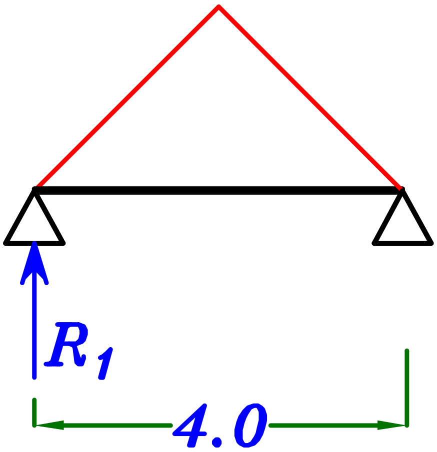
$$w_2 = O.W. + \frac{C_a}{C_e}\, w_s\, \frac{L_c}{2}$$



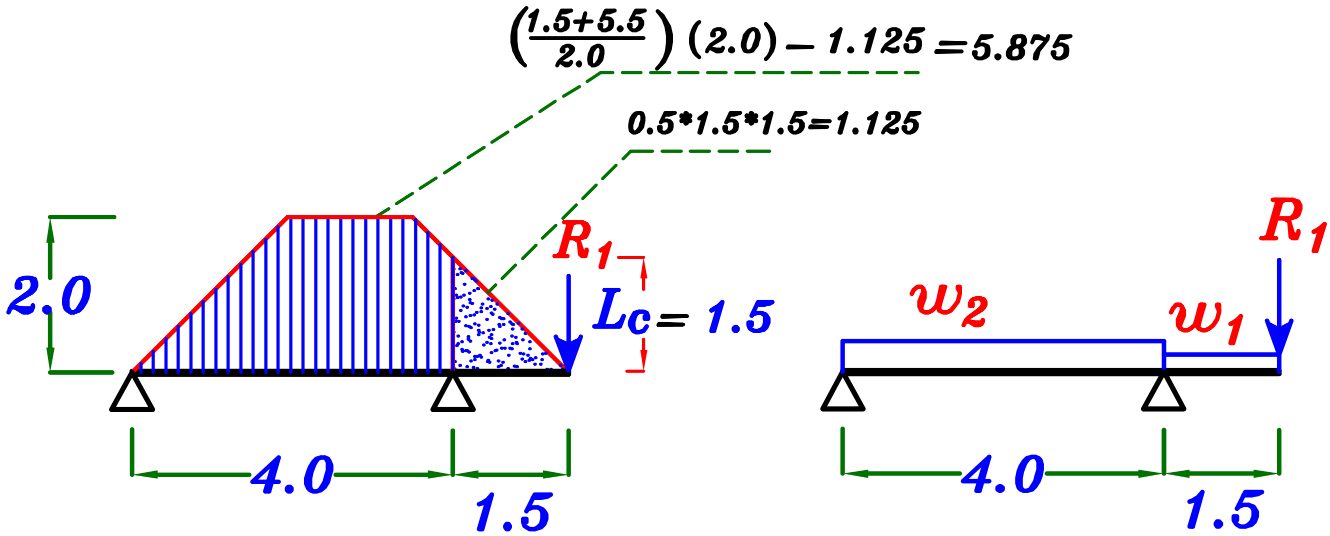
Example.

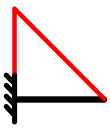


B_1



B_2



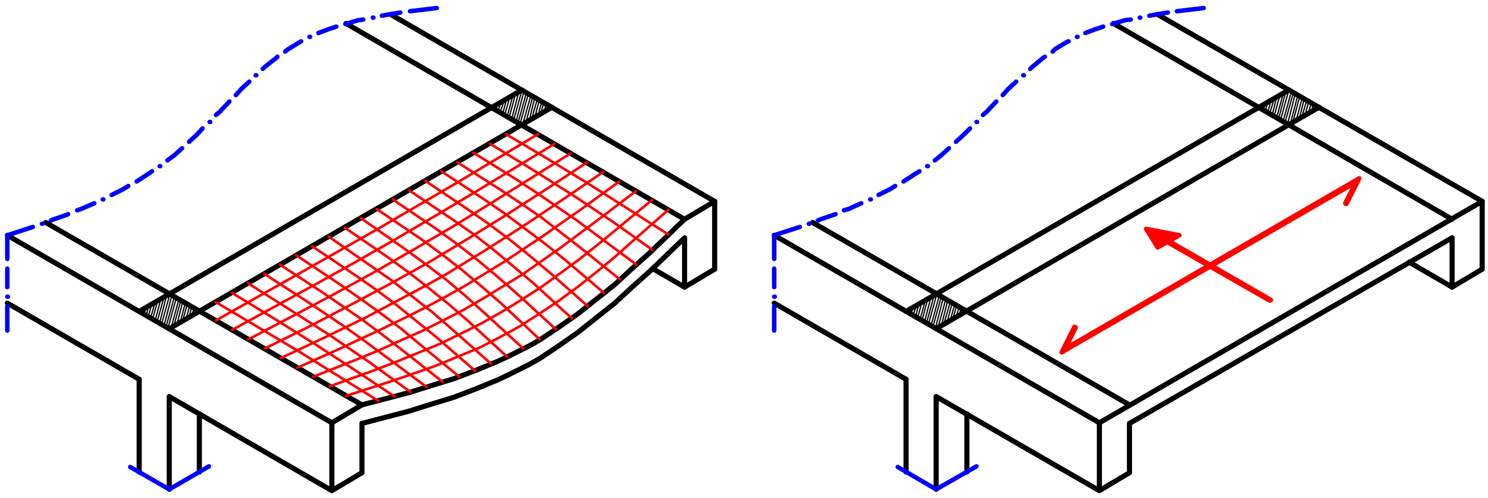


$$w_1 = O.W. + \frac{C_a}{C_e}\, w_s\, L_c \qquad \text{where: } L_c = 1.5$$

$$w_2 = O.W. + \frac{\sum area}{Span} * w_s = O.W. + \frac{(5.875)}{(4.0)} * w_s$$

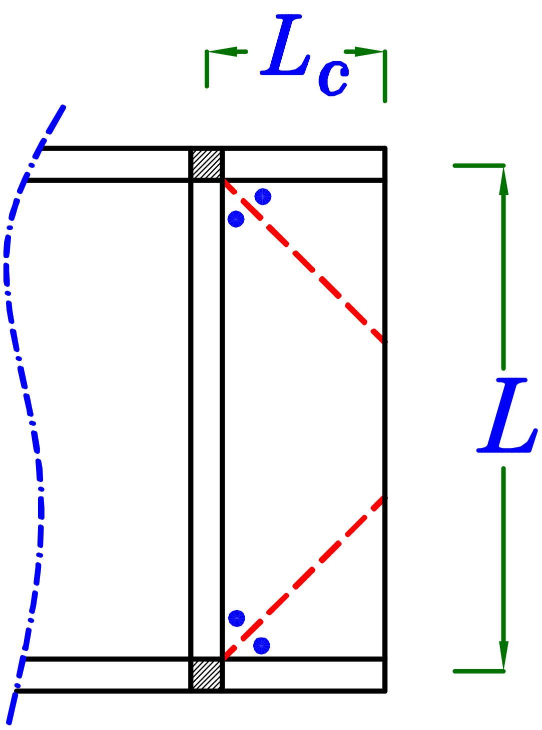
3 Sided Slabs

هى بلاطات مستطيله محموله من ثلاث جهات فقط.

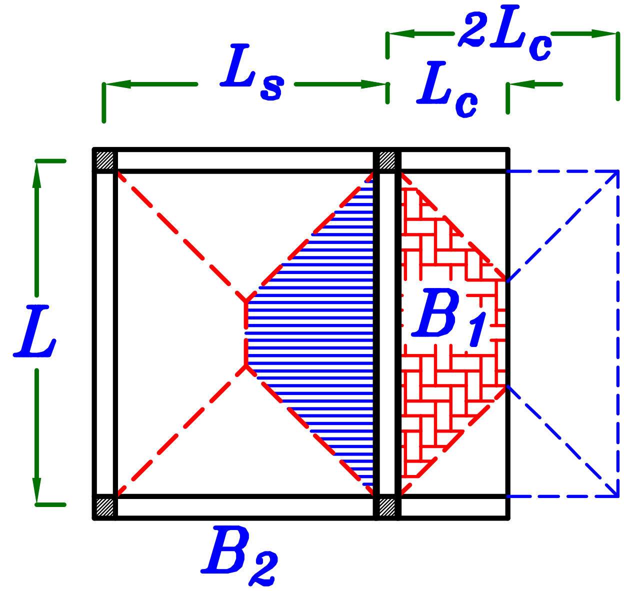


و يتوزع حمل البلاطه على الثلاث كمرات .

و لتوزيع حمل البلاطه على الكمرات يتم تنصيف الزوايا بين الكمرات .



و توجد ثلاث حالات لل 3 Sided Slabs

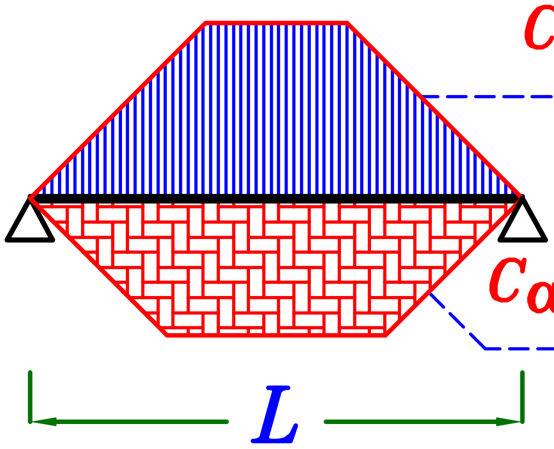


① IF $\boxed{L_c < \frac{L}{2}}$

لحساب ال C_a و ال C_e لل trapezium

نحسب قيمه L و L_s للبلاطه ال two way التى كان سيأتى منها نفس ال trapezium

B_1



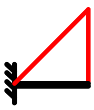
$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right)$$

$$C_a = 1 - \frac{1}{2}\left(\frac{2L_c}{L}\right)$$

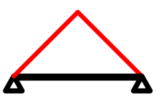
B_2

$C_a = \frac{1}{2}$

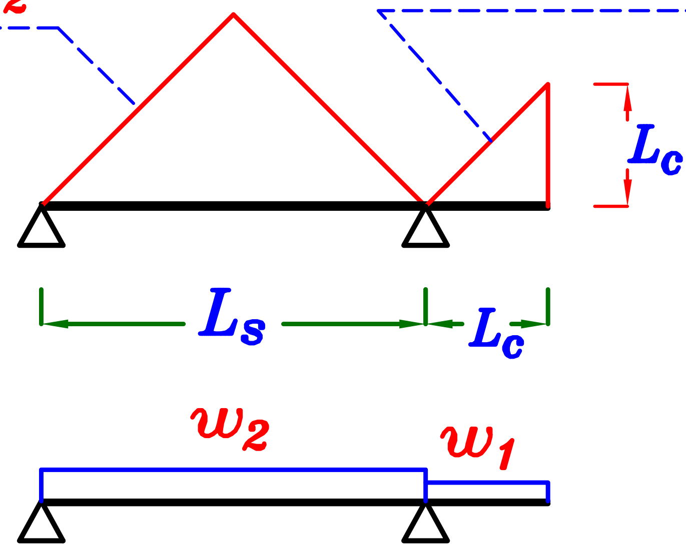
$C_a = \frac{1}{2}\ ,\ C_e = \frac{2}{3}$



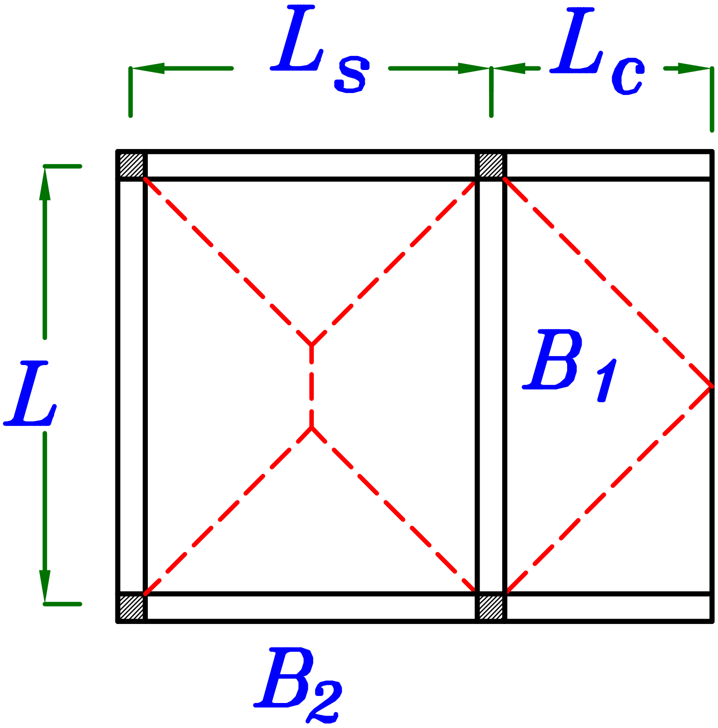
$$w_1 = O.W. + C_a \; w_s \; L_c$$



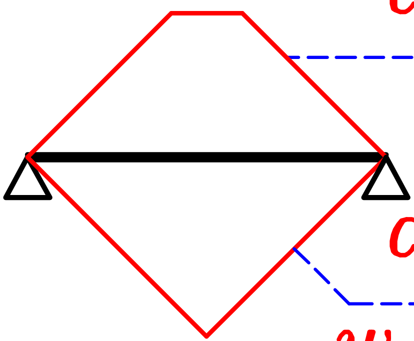
$$w_2 = O.W. + C_a \; w_s \; \frac{L_s}{2}$$



② IF $\boxed{L_c = \frac{L}{2}}$



$\underline{\underline{B_1}}$

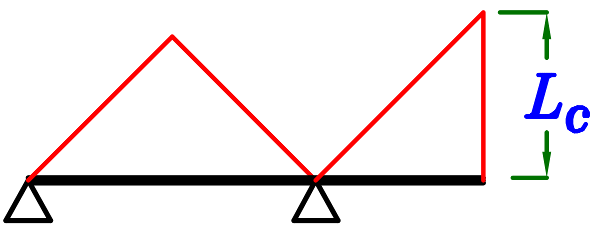


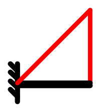
$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right)$$

$$C_a = \frac{1}{2}$$

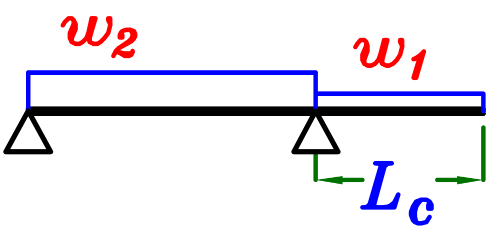
$$w = o.w. + C_a \; w_s \; L_c$$

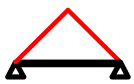
$\underline{\underline{B_2}}$





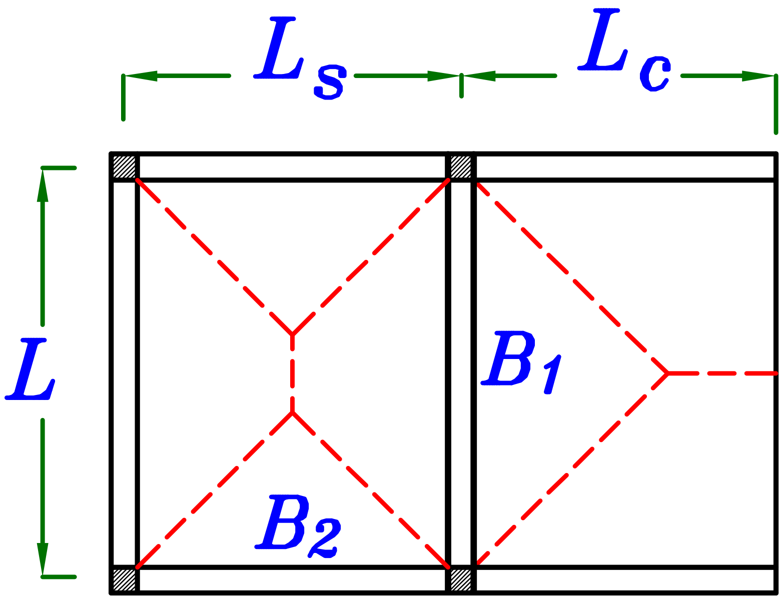
$$w_1 = 0.W. + C_a \; w_s \; L_c$$



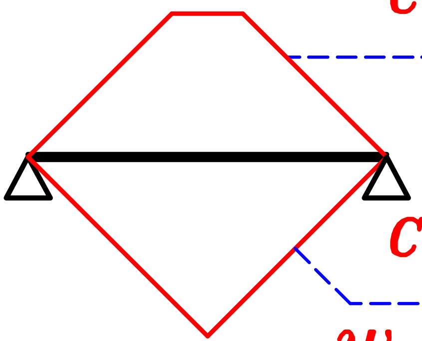


$$w_2 = 0.W. + C_a \; w_s \; \frac{L_s}{2}$$

③ IF $\boxed{L_c > \frac{L}{2}}$



B_1

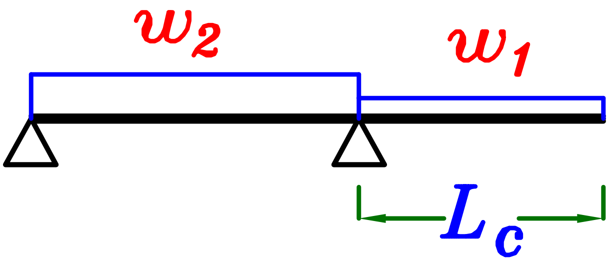


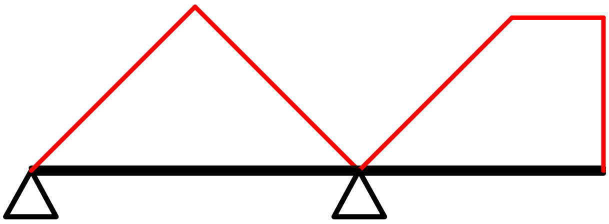
$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right)$

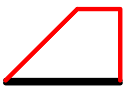
$C_a = \frac{1}{2}$

$$w = o.w. + C_a\, w_s\, \frac{L}{2}$$

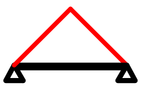
B_2







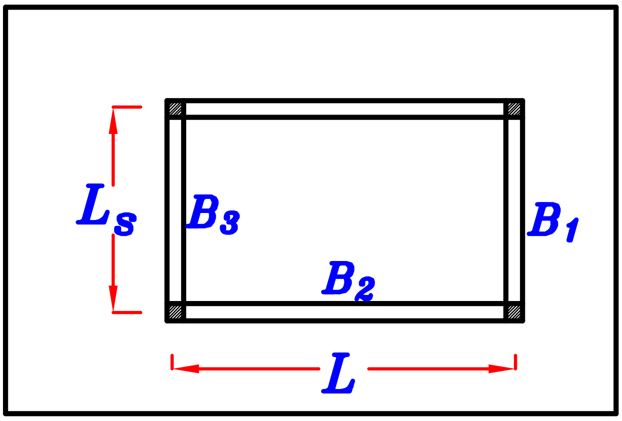
$$w_1 = O.W. + \frac{\sum area}{Span} * w_s$$



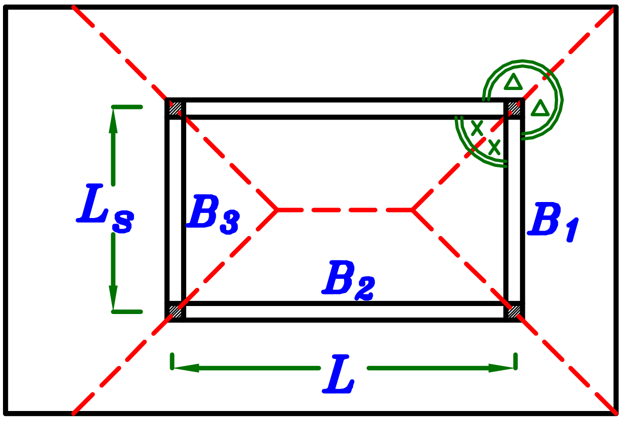
$$w_2 = O.W. + C_a\, w_s\, \frac{L_s}{2}$$

Slabs with external angles.

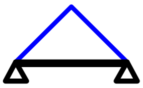
Example.

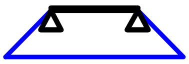


يتم تنصيف الزوايا الداخليه و الخارجيه بين الكمرات

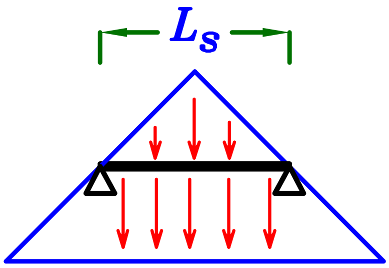


B_1

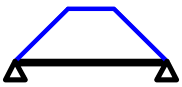


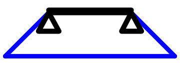


$$w_1 = O.W. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{Span = L_s} * w_s$$

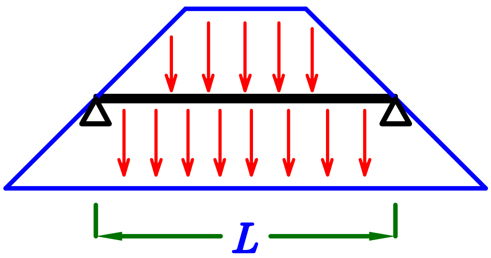


B_2

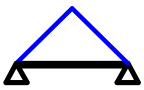


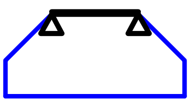


$$w_3 = O.W. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{Span = L} * w_s$$

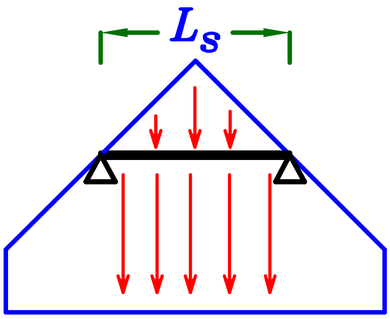


B_3

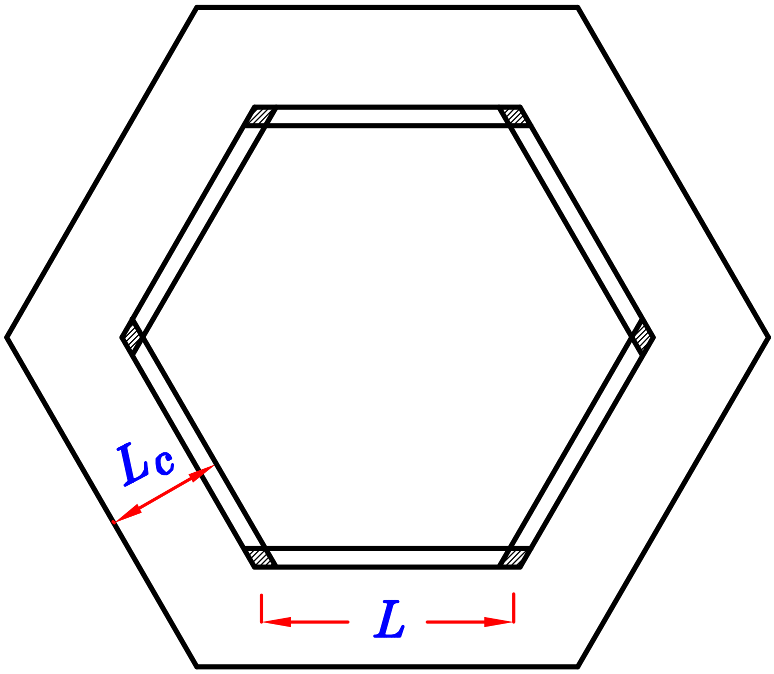


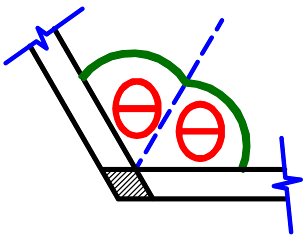


$$w_2 = O.W. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{Span = L_s} * w_s$$

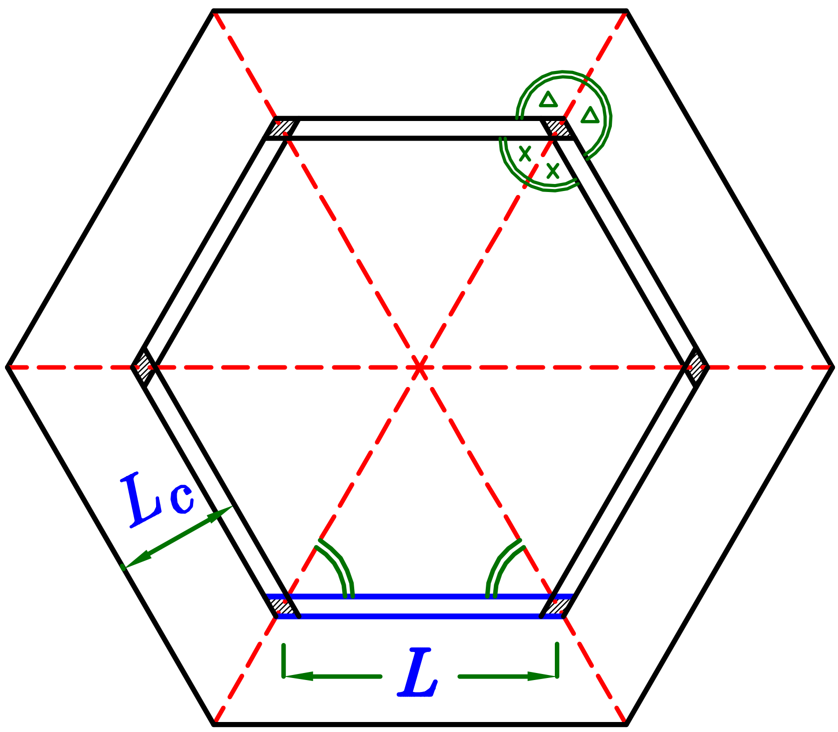


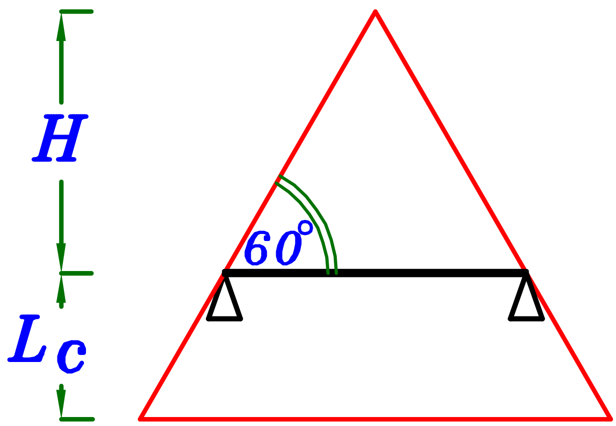
Example.

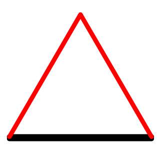




يتم تصنيف الزوايا بين الكمرات حتى لو لم تكن ٩٠°

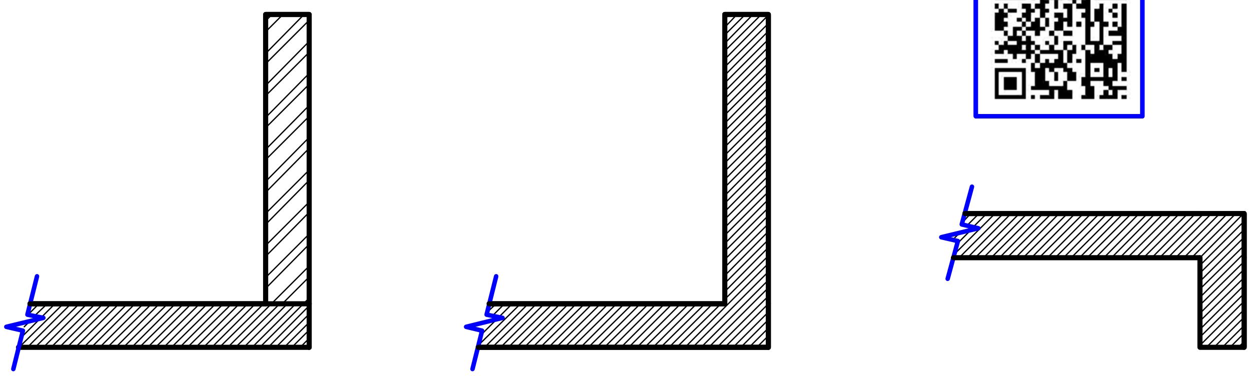






$$w = O.W. + C_a w_s H + \frac{\sum area}{Span} * w_s$$

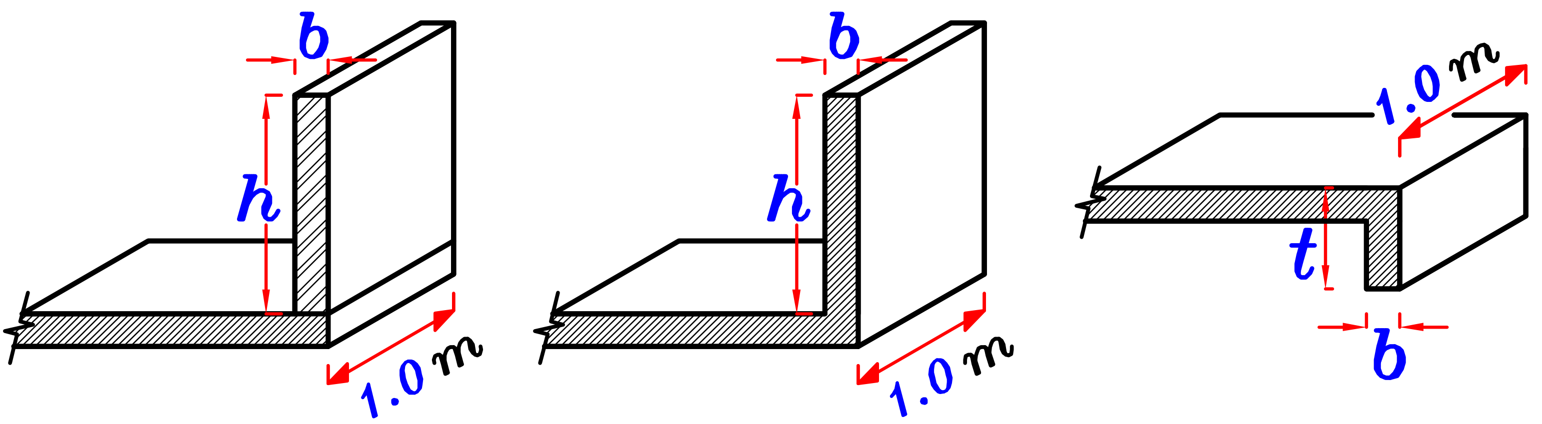
Parapet rested on slabs.



سور   دروه   مرايه

لحساب وزن متر طولى من ال

Fence   **Parapet**   **Mirror**



$\boxed{b\,h\,\gamma_w}$ $\boxed{b\,h\,\gamma_c}$ $\boxed{b\,t\,\gamma_c}$

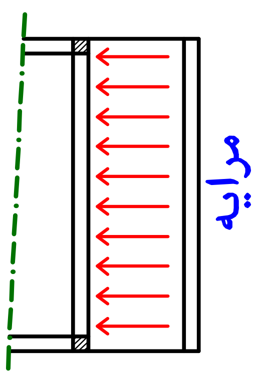
يوجد فرق مهم جدا بين الكمره و المرايه .

الكمره تحمل البلاطه لكن المرايه محموله على البلاطه ال *cantilever*

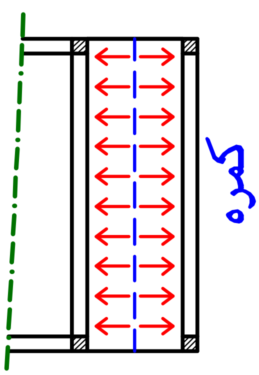
الكمره يجب ان تكون محموله على الاقل على *2 supports* مثل الاعمده او الكمرات

لكن المرايه تكون محموله مباشره على البلاطه .

المرايه ليست محموله على كمرات او اعمده لكنها محموله على البلاطه ال *cantilever*



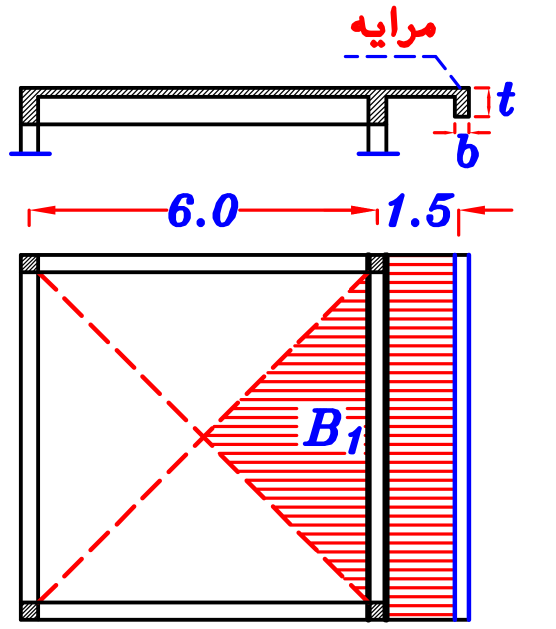
الكمره يجب ان تكون محموله على الاقل على *2 supports* الكمره هى التى تحمل البلاطه



توجد حالتان لحساب وزن (السور او الدروه او المرايه) على الكمره

١- اذا كان طول المرايه هو نفس طول الكمره .

اذا المتر الطولى من الكمره يحمل وزن متر طولى من المرايه .



وزن متر طولى $o.w.(\text{المراية}) = b\ t\ \gamma_c$

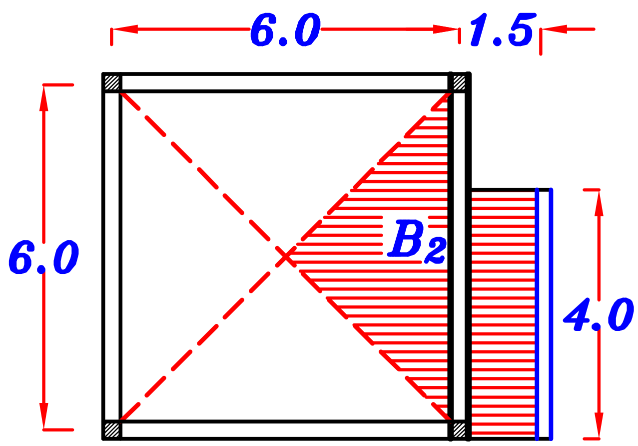
B_1

وزن متر طولى من المرايه

$$w = o.w.(\text{الكمره}) + b\ t\ \gamma_c + w_s L_c + C_a w_s \frac{L_s}{2}$$

٢- اذا كان طول المرايه ليس نفس طول الكمره .

المتر الطولى من الكمره لا يحمل متر من المرايه لذلك سنحتاج لحل تقريبى



$$\boxed{w = \frac{\sum weight}{Span}}$$

بأن نحسب الوزن الكلى للمرايه و نقسمه على طول الكمره .

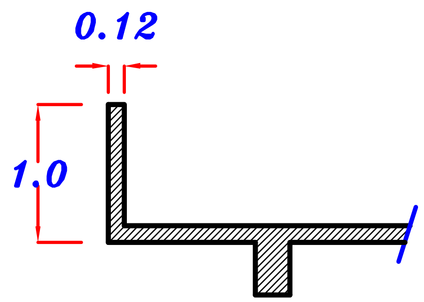
$$\sum weight\ (\text{المرايه}) = (b)\ (t)\ \gamma_c * 4.0 = \checkmark\ kN$$

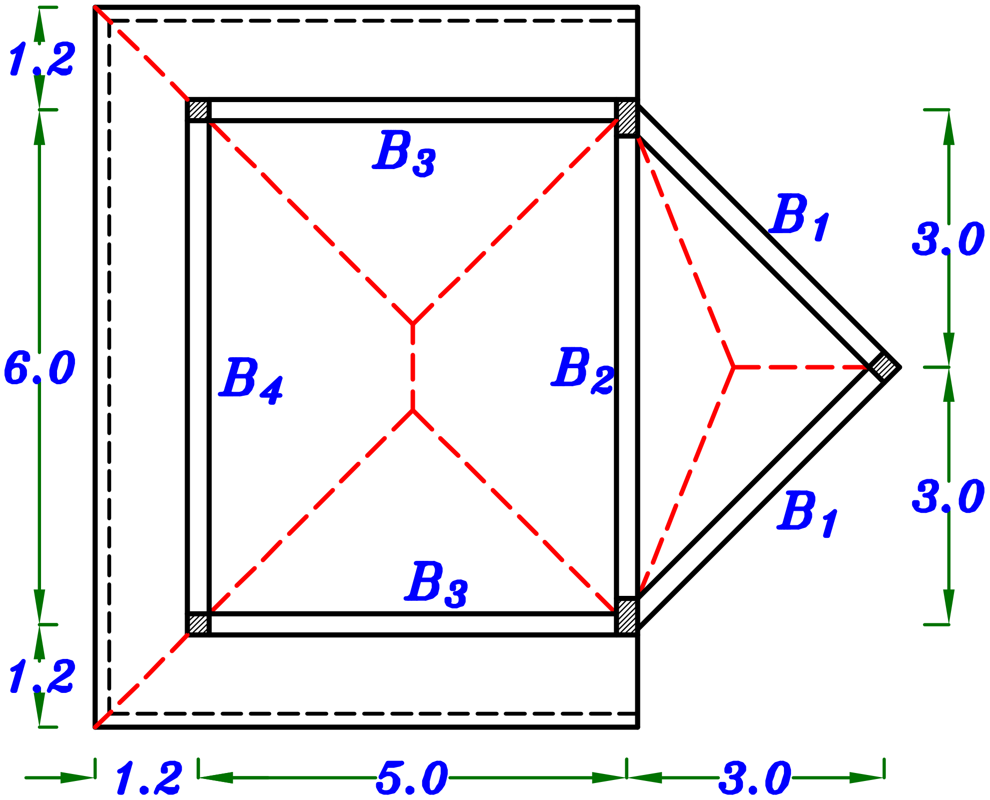
B_2

الوزن الكلى للمرايه

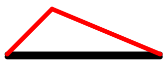
$$w = o.w. + C_a w_s \frac{L_s}{2} + \frac{\sum area}{Span = 6.0\ m} * w_s + \frac{\sum weight}{Span = 6.0\ m}$$

Example.

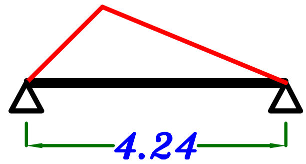




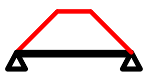
B1

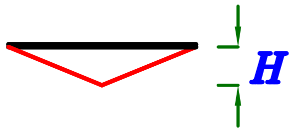


$$w_1 = O.W. + \frac{\sum area}{Span = 4.24\,m} * w_s$$

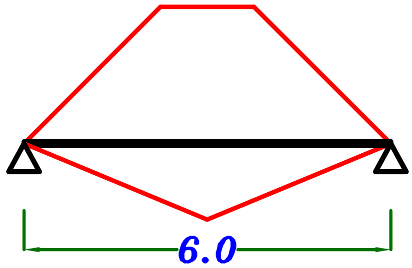


B2

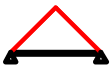




$$w_2 = O.W. + C_a\, w_s\, \frac{L_s}{2} + C_a\, w_s\, H$$

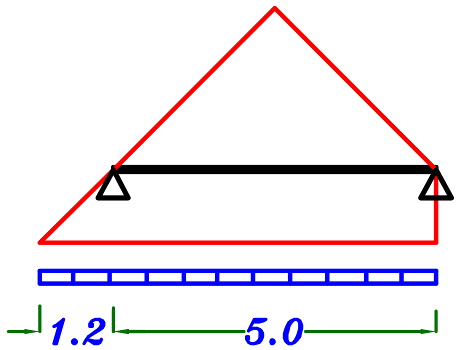


B3

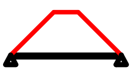


$$w_3 = O.W. + C_a\, w_s\, \frac{L_s}{2} + \frac{\sum area}{Span = 5.0} * w_s + \frac{\sum weight}{Span = 5.0}$$

Fence

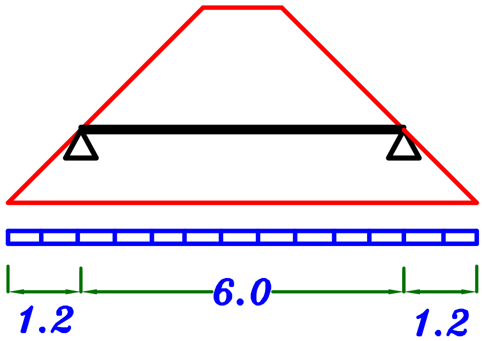


B4

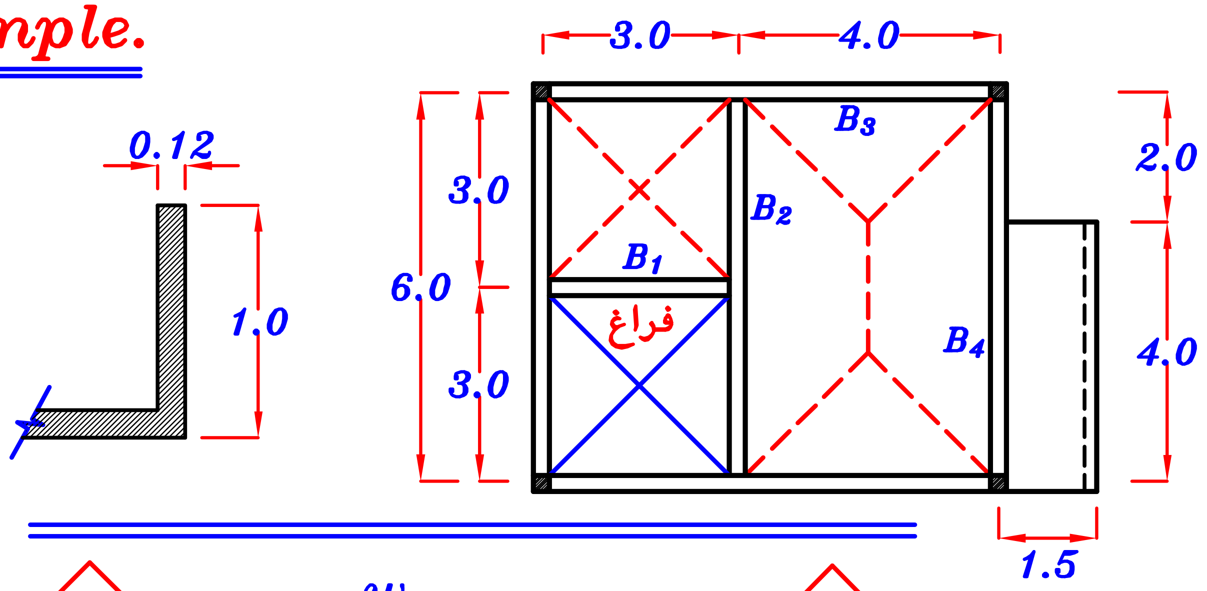


$$w_4 = O.W. + C_a\, w_s\, \frac{L_s}{2} + \frac{\sum area}{Span = 6.0} * w_s + \frac{\sum weight}{Span = 6.0}$$

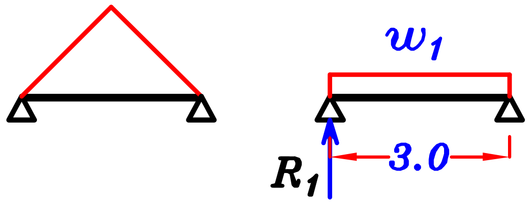
Fence



Example.

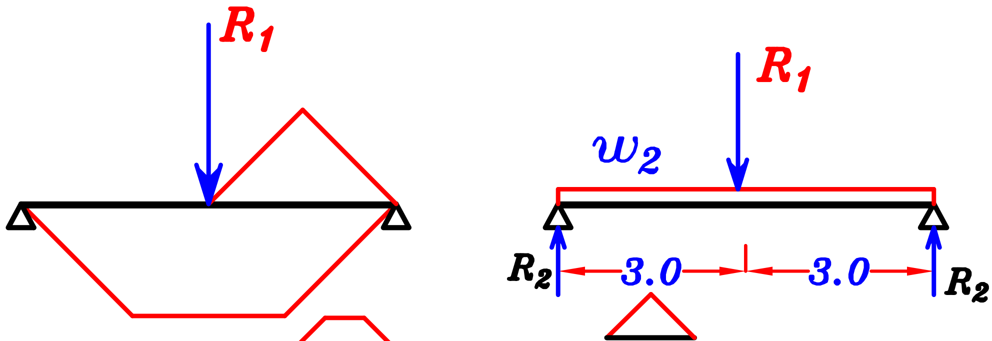


B_1



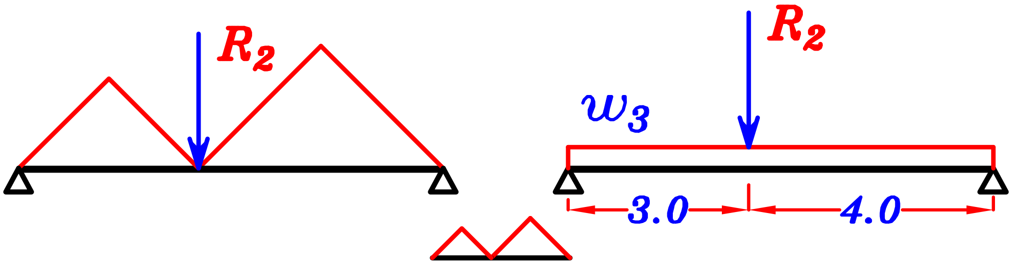
$$w_1 = O.W. + C_a \; w_s \; \frac{L_s}{2}$$

B_2



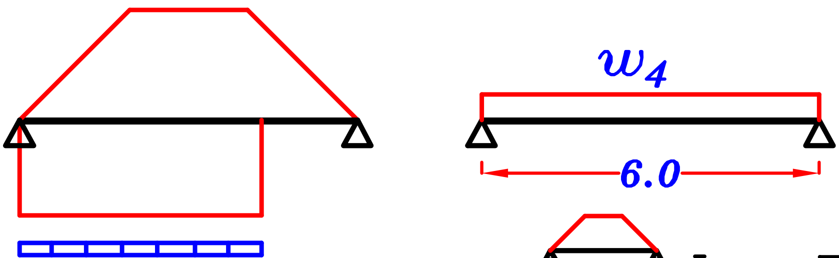
$$w_2 = O.W. + C_a \, w_s \, \frac{L_s}{2} + \frac{\sum area}{Span = 6.0\, m} * w_s$$

B_3



$$w_3 = O.W. + \frac{\sum area}{Span = 6.0\, m} * w_s$$

B_4



Fence

$$w_4 = O.W. + C_a \, w_s \, \frac{L_s}{2} + \frac{\sum area}{Span = 6.0\, m} * w_s + \frac{\sum weight}{Span = 6.0}$$

Weight of the Fence $= (0.12 * 1.0 * 4.0)\,(25.0)$

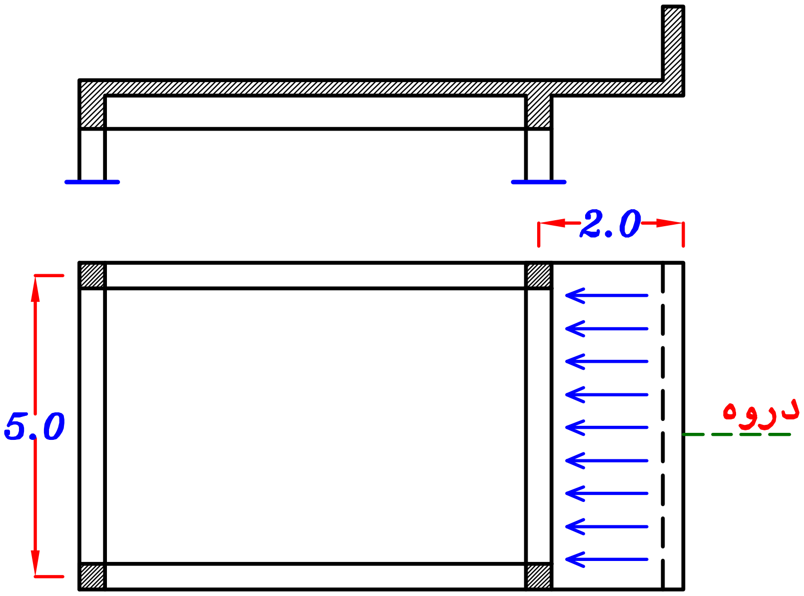
Example.

لانه لا يوجد للدروه اى **supports**

اذا هى محموله على البلاطه

اذا البلاطه محموله على كمره واحده فقط

اذا البلاطه تكون **Cantilever Slab**



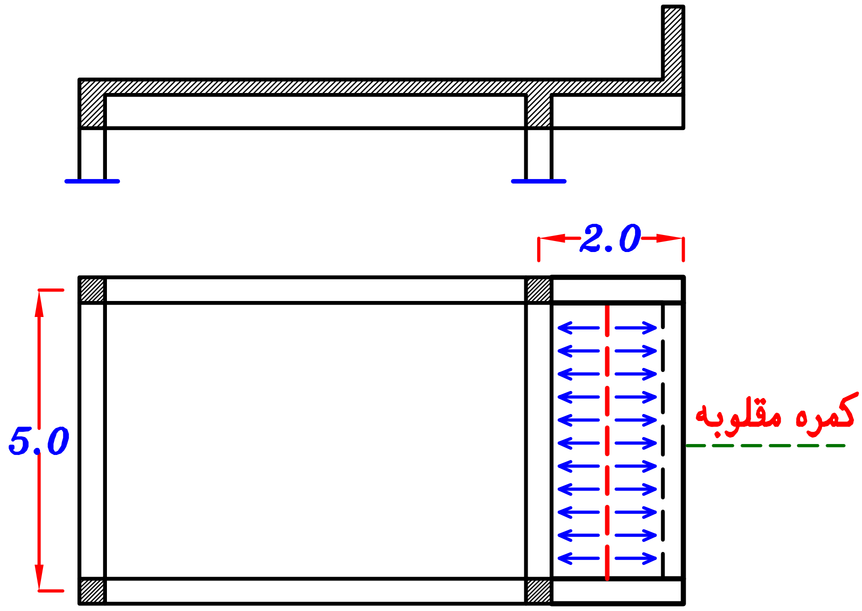
لان الدروه محموله على **2 supports**

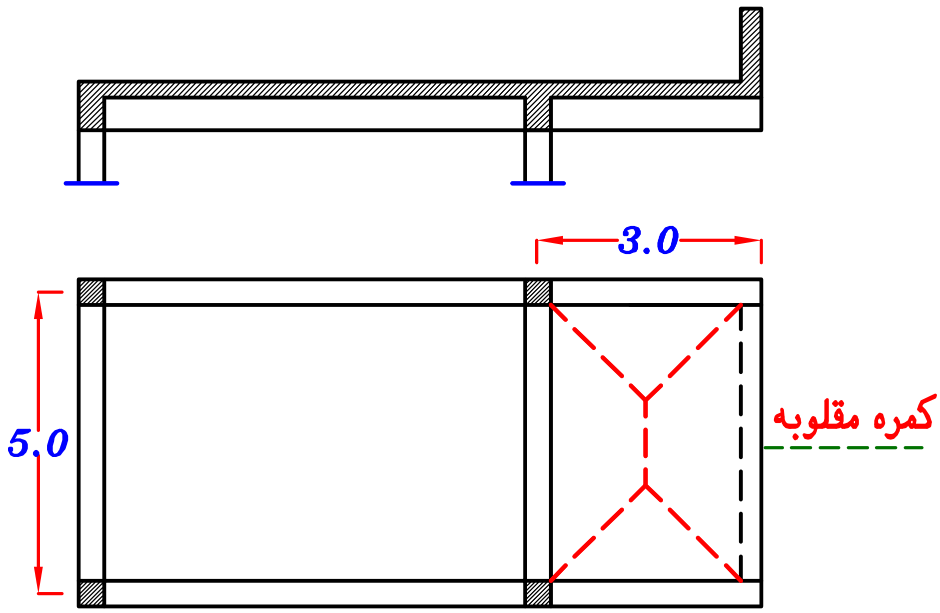
اذا ستكون كمره مقلوبه .

اذا ستكون البلاطه محموله على ٤ كمرات

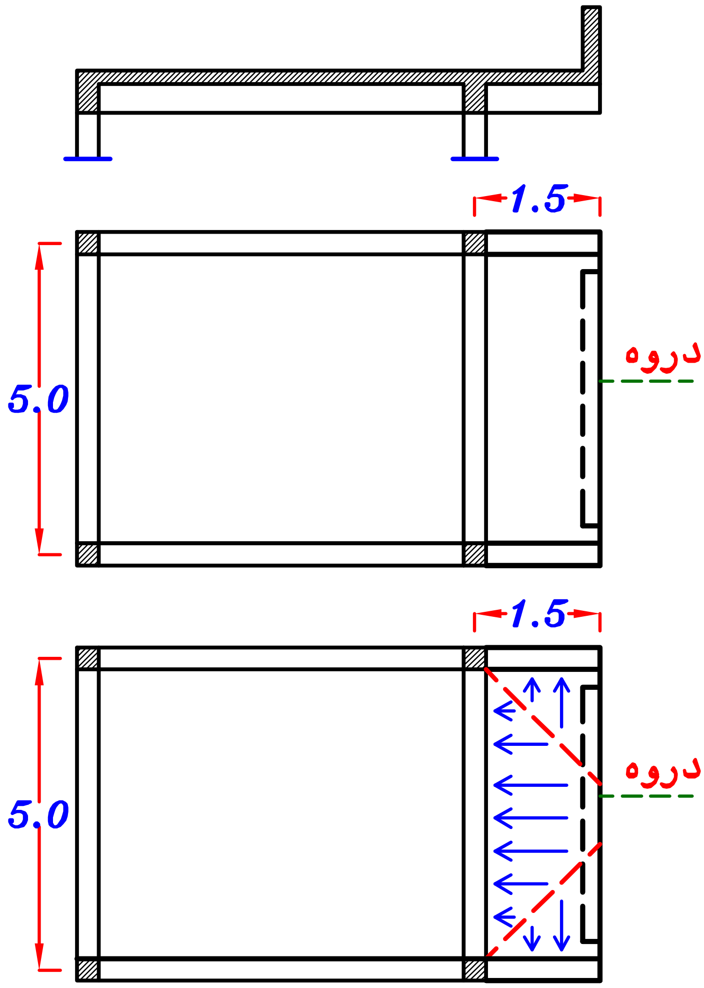
اذا ستكون البلاطه اما **One way**

او **Two way** على حسب ابعادها .





Example.



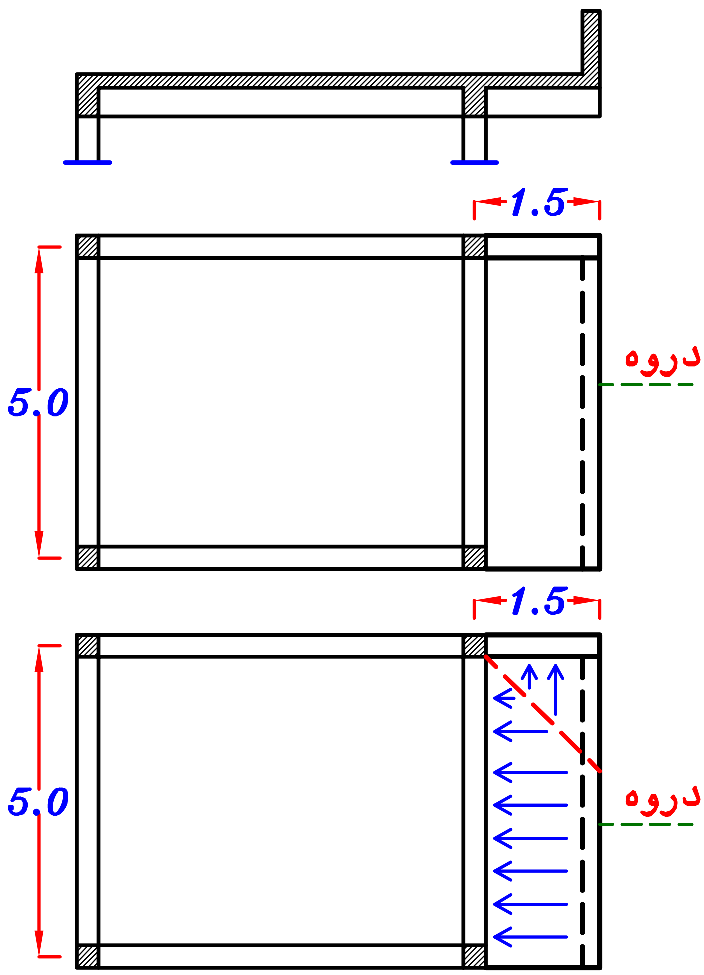
في هذا المثال الدروه ليست متصله بالكمرات

اذا هي محموله فقط على البلاطه

اذا البلاطه محموله على ثلاث كمرات فقط

اذا البلاطه **3 sided slab**

Example.



الدروه محموله على كمره واحده فقط

اذا لكي تكون متزنه يجب ان تكون

محموله على البلاطه ايضا .

اذا البلاطه محموله على كمرتين فقط

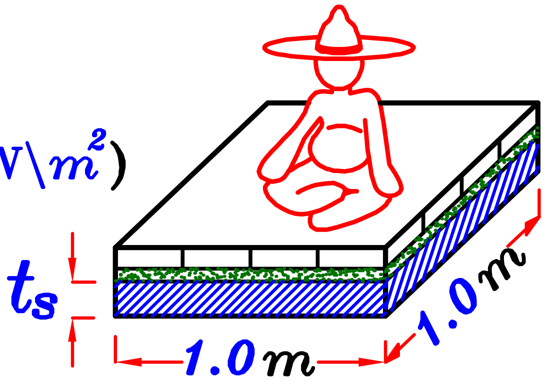
اذا البلاطه تكون **2 sided slab**

Max−Max B.M.D.

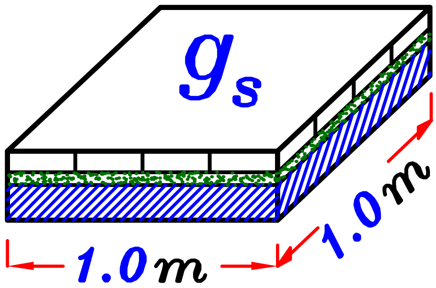
لرسم *max−max B.M.D.* للكمره يجب أولا أن نعمل
على حساب كلا من *Dead Load* و ال *Live Load* على حده .

Load of the Slab.

$$\boxed{w_s = t_s * \gamma_c + F.C. + L.L.} \quad (kN\backslash m^2)$$

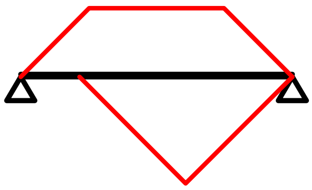


$$\boxed{g_s = t_s * \gamma_c + F.C.} \quad (kN\backslash m^2)$$



$$\boxed{p_s = L.L.} \quad (kN\backslash m^2)$$

لحساب الاحمال على الكمره فى حاله ال *Total Load*



$$w_a = O.W. + C_a\, w_s \frac{L_s}{2} + \frac{\sum area}{Span} * w_s$$

لكن لحساب الاحمال فى حاله ال *max−max*

يتم حساب كلا من *D.L. & L.L.* على حده و جمعهم لحساب ال *T.L.*

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + \frac{\sum area}{Span} * g_s$$

$$p_a = C_a\, p_s \frac{L_s}{2} + \frac{\sum area}{Span} * p_s$$

$$w_a = g_a + p_a$$

خطوات حل مسائل Load Distribution

١- ننقل الـ plan فى ورقه الاجابه (مسائل الـ plans)

نستنتج الـ plan و نرسمه فى ورقه الاجابه (مسائل الـ X-sec.)

يفضل الرسم بمقياس رسم ١ : ١٠٠

٢- نرسم شكل Load Distribution Pattern على الـ plan .

٣- نرقم الكمرات B_1 , B_2 , B_3 ..... (يتم ترقيم الكمرات المحموله أولا)

و اذا وجد كمرتان لهم نفس الطول و نفس الاحمال نرقمهم بنفس الترقيم .

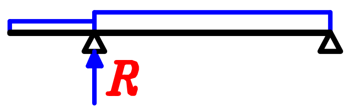
٤- نحسب قيمه w_s (اذا كانت المسأله Total Load)

نحسب قيمه g_s , p_s (اذا كانت المسأله max-max)

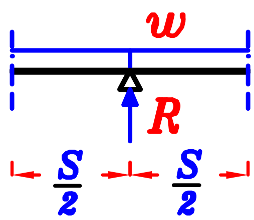
نحسب o.w. الكمرات اذا لم تكن معطاه .

نحسب وزن الحوائط إن وجدت .

٥- نحسب قيمه Reactions للكمرات المحموله على الـ Girder .



(فى مسائل الـ plans نحسب الـ R مثل الـ structure)



(فى مسائل الـ X-sec. نحسب الـ $R = w * S$)

٦- نضع الاحمال على الـ Girder بالترتيب التالى :-

أ- نضع o.w. على الـ Girder كله .

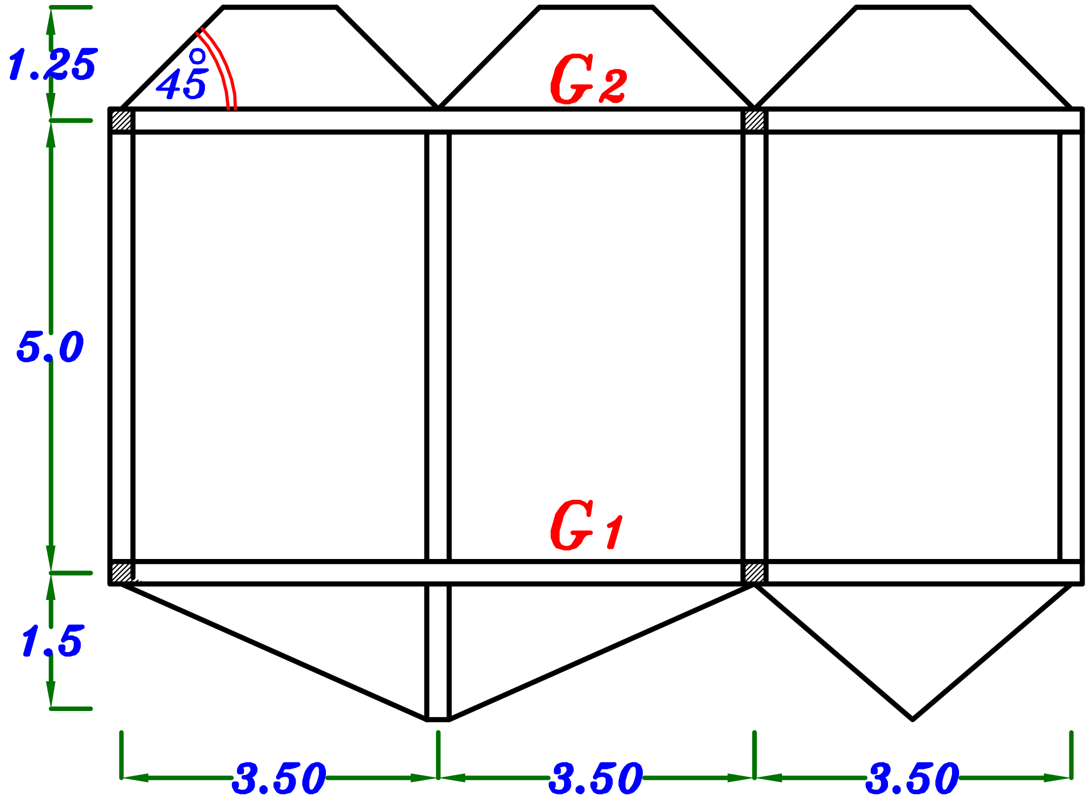
ب - نضع Reactions الكمرات الثانويه concentrated loads على الـ Girder .

ج - نضع أحمال البلاطه التى تنتقل مباشره من البلاطه الى الـ Girder .

و تظهر هذه الاحمال من الـ plan .

٧- نرسم B.M.D. & S.F.D. للـ Girder حسب المطلوب Total Load or max-max. .

Example.



Data.

$t_s = 0.14\ m$

$F.C. = 2.0\ kN\backslash m^2$

$L.L. = 2.0\ kN\backslash m^2$

b (Beams & Girders) = 0.25 m

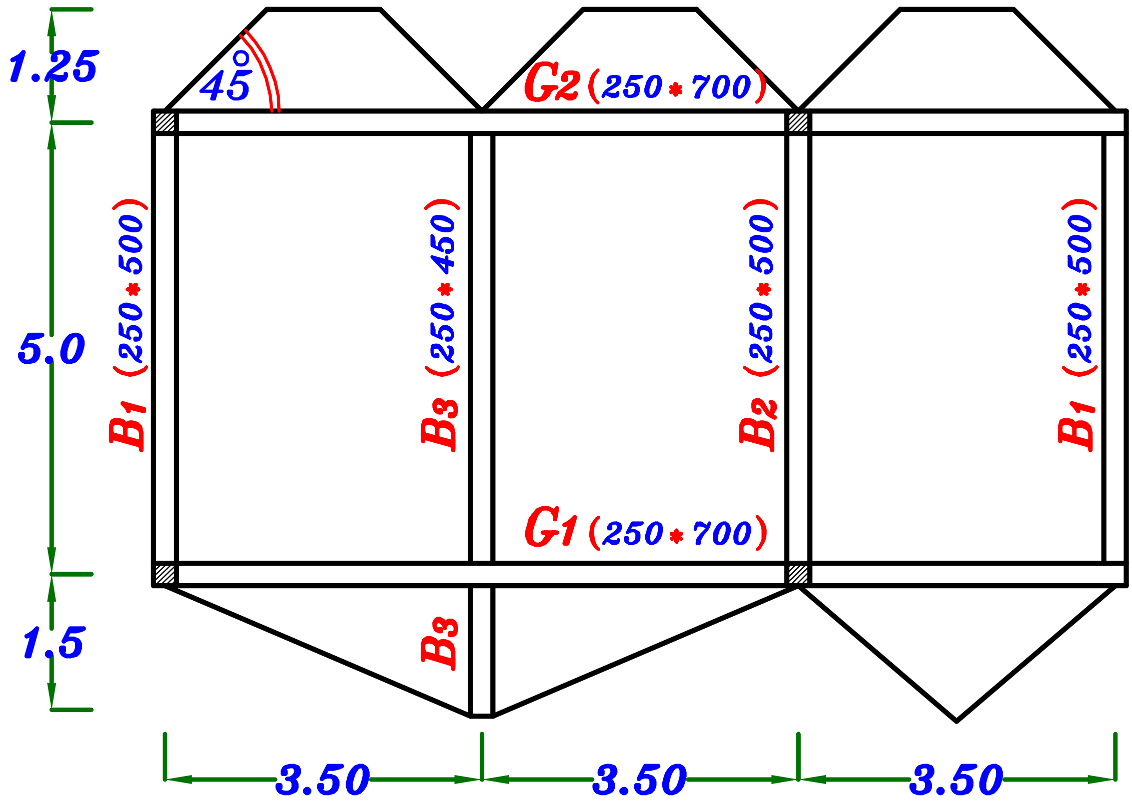
O.W. of beams & girders are reasonably assumed according to the expected depth.

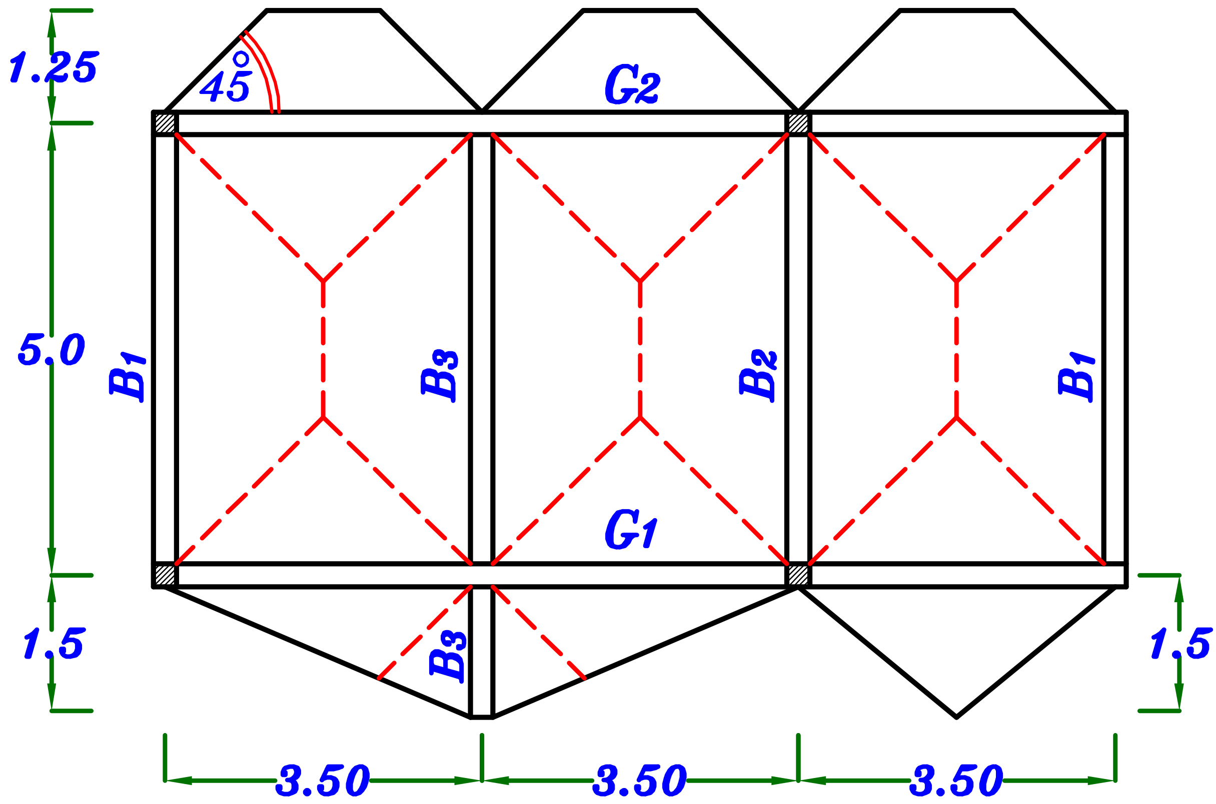
Req.

1- Draw the structural plan showing the pattern of Load Distribution.

2- Draw S.F.D. & Absolute B.M.D. For the Girders G_1 & G_2

Get b , t and o.w. For all beams.





g_s , p_s

$$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 2.0 = 5.50 \ kN\backslash m^2$$

$$p_s = L.L. = 2.0 \ kN\backslash m^2$$

$$\boxed{g_s = 5.50 \ kN\backslash m^2} \ , \ \boxed{p_s = 2.0 \ kN\backslash m^2}$$

---

o.w. of Beams. $= b \ t \ \gamma_c$

B_1 , B_2 $(250*500)$ o.w. $= (0.25)(0.5)(25) = 3.12 \ kN\backslash m'$

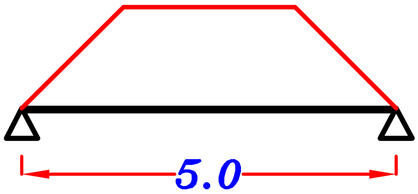
B_3 $(250*450)$ o.w. $= (0.25)(0.45)(25) = 2.81 \ kN\backslash m'$

G_1 , G_2 $(250*700)$ o.w. $= (0.25)(0.7)(25) = 4.40 \ kN\backslash m'$

B_1 $(250*500)$

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.50}{5}\right) = 0.65$$



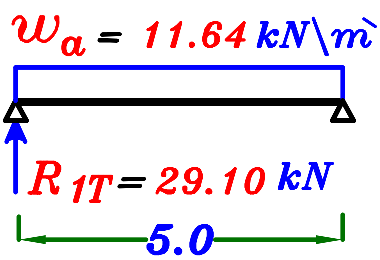
Load For shear.

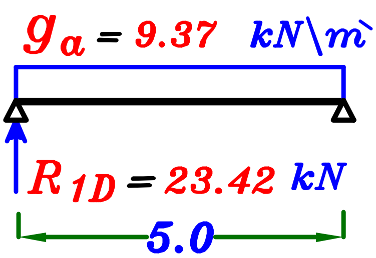
$$g_a = O.W. + C_a \ g_s \ \frac{L_s}{2} = 3.12 + 0.65 \ (5.50)\left(\frac{3.50}{2}\right) = 9.37 \ kN\backslash m$$

$$p_a = C_a \ p_s \ \frac{L_s}{2} = 0.65 \ (2.0)\left(\frac{3.50}{2}\right) = 2.27 \ kN\backslash m$$

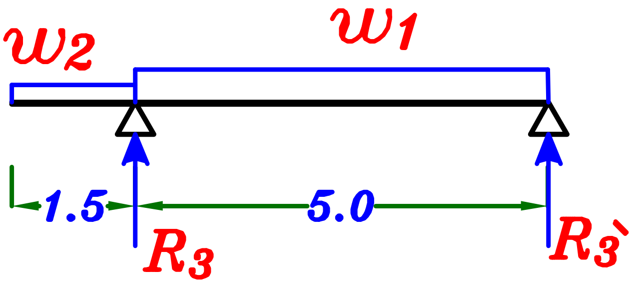
$$w_a = g_a + p_a = 9.37 + 2.27 = 11.64 \ kN\backslash m'$$

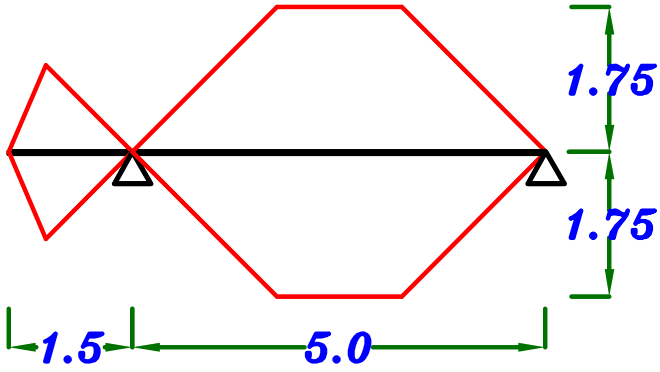
$$\boxed{\begin{array}{l} R_{1D} = 23.42 \ kN \\ R_{1T} = 29.10 \ kN \end{array}}$$





B_3 (250*450)





w_1

For Trapezoid $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.50}{5}\right) = 0.65$

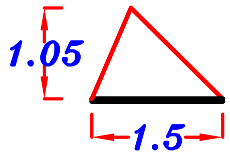
Load For shear.

$$g_1 = O.W. + 2\,C_a\, g_s \frac{L_s}{2} = 2.81 + 2\,(0.65)(5.50)\left(\frac{3.50}{2}\right) = 15.32 \ kN\backslash m$$

$$p_1 = 2\,C_a\, p_s \frac{L_s}{2} = 2\,(0.65)(2.0)\left(\frac{3.50}{2}\right) = 4.55 \ kN\backslash m$$

$$w_1 = g_1 + p_1 = 15.32 + 4.55 = 19.87 \ kN\backslash m`$$

w_2



$area = 0.787 \ m^2$

$$g_2 = O.W. + \frac{\sum area}{Span} * g_s = 2.81 + \frac{2\,(0.787)(5.50)}{1.50} = 8.58 \ kN\backslash m$$

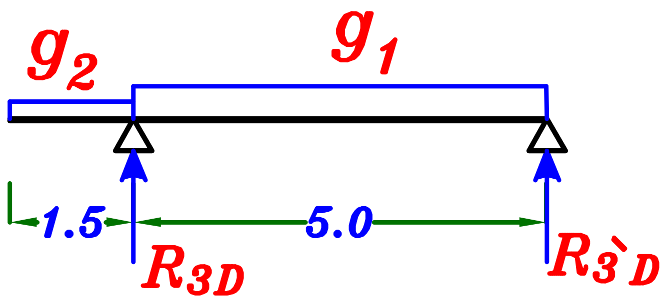
$$p_2 = \frac{\sum area}{Span} * p_s = \frac{2\,(0.787)(2.0)}{1.50} = 2.10 \ kN\backslash m$$

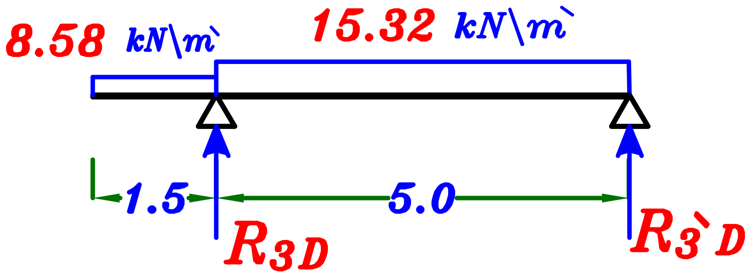
$$w_2 = g_2 + p_2 = 8.58 + 2.10 = 10.68 \ kN\backslash m`$$

Dead Load.

$R_{3D} = 53.1\ kN$

$R_{3`D} = 36.37\ kN$

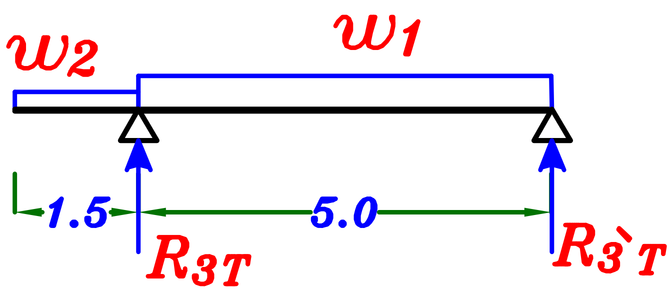


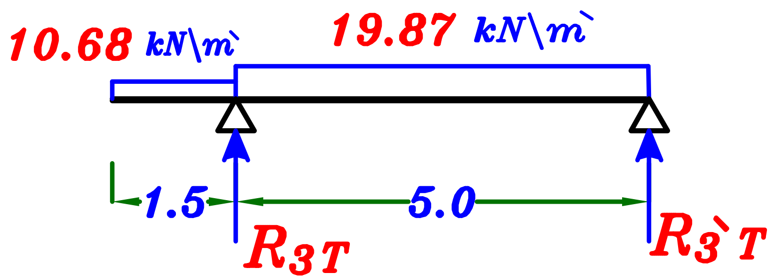


Total Load.

$R_{3T} = 68.1\ kN$

$R_{3`T} = 47.27\ kN$

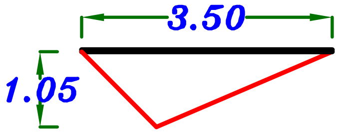




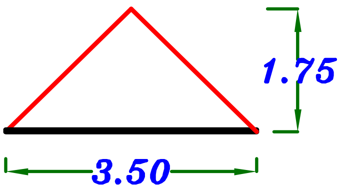
$$\left.\begin{aligned} R_{3D} &= 53.1\ kN \\ R_{3T} &= 68.1\ kN \end{aligned}\right\} \text{Reversed on girder } G_1$$

$$\left.\begin{aligned} R_{3`D} &= 36.37\ kN \\ R_{3`T} &= 47.27\ kN \end{aligned}\right\} \text{Reversed on girder } G_2$$

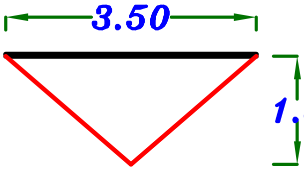
G_1 (250 * 700)



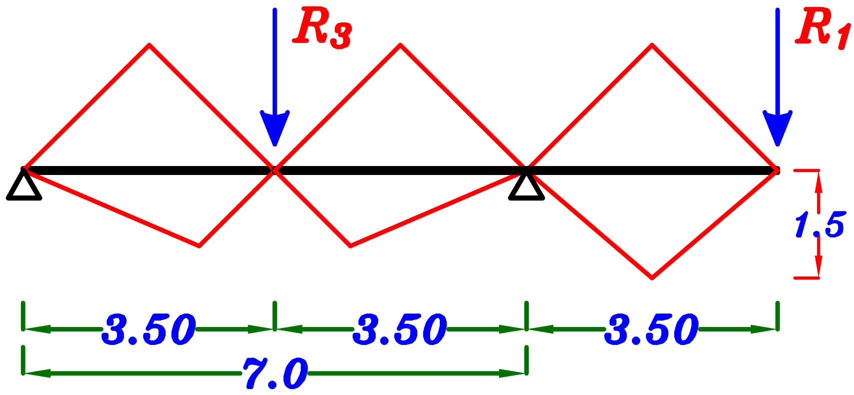
$area = 1.837\ m^2$

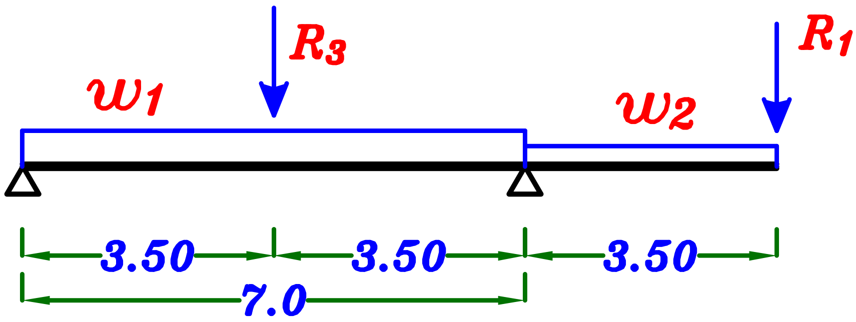


$area = 3.062\ m^2$



$area = 2.625\ m^2$





w_1

No C_a , C_e $\longrightarrow$ Load For Shear = Load For Moment

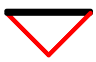
$$g_1 = O.W. + \frac{\sum area}{Span} * g_s$$

$$= 4.40 + \frac{2\,(1.837) + 2\,(3.062)}{7.0}\,(5.50) = 12.10\ kN\backslash m$$

$$p_1 = \frac{\sum area}{Span} * p_s = \frac{2\,(1.837) + 2\,(3.062)}{7.0}\,(2.0) = 2.80\ kN\backslash m$$

$$w_1 = g_1 + p_1 = 12.10 + 2.80 = 14.90\ kN\backslash m'$$

w_2



$$g_2 = O.W. + \frac{\sum area}{Span} * g_s + C_e\, g_s\, \frac{L_c}{2}$$

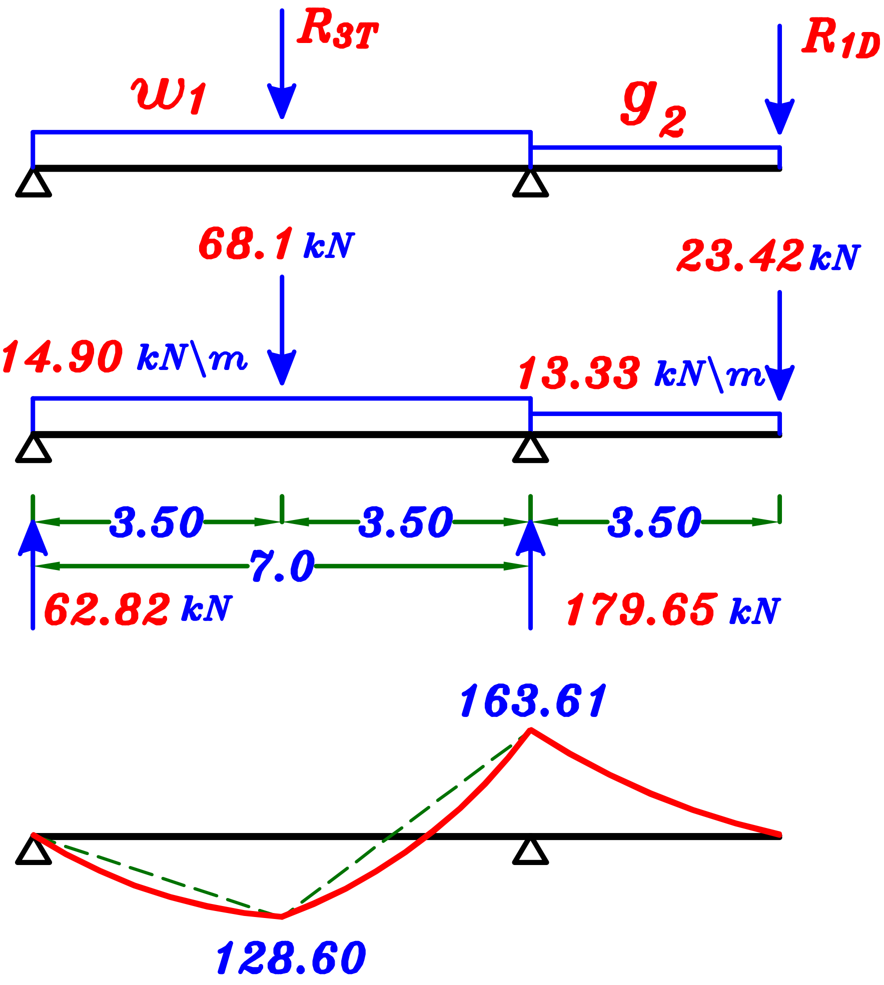
$$= 4.40 + \frac{(2.625)}{3.50}\,(5.50) + \frac{1}{2}\,(5.50)\left(\frac{3.50}{2}\right) = 13.33\ kN\backslash m$$

$$p_2 = \frac{\sum area}{Span} * p_s + C_e\, p_s\, \frac{L_c}{2} = \frac{(2.625)}{3.50}\,(2.0) + \frac{1}{2}\,(2.0)\left(\frac{3.50}{2}\right) = 3.25\ kN\backslash m$$

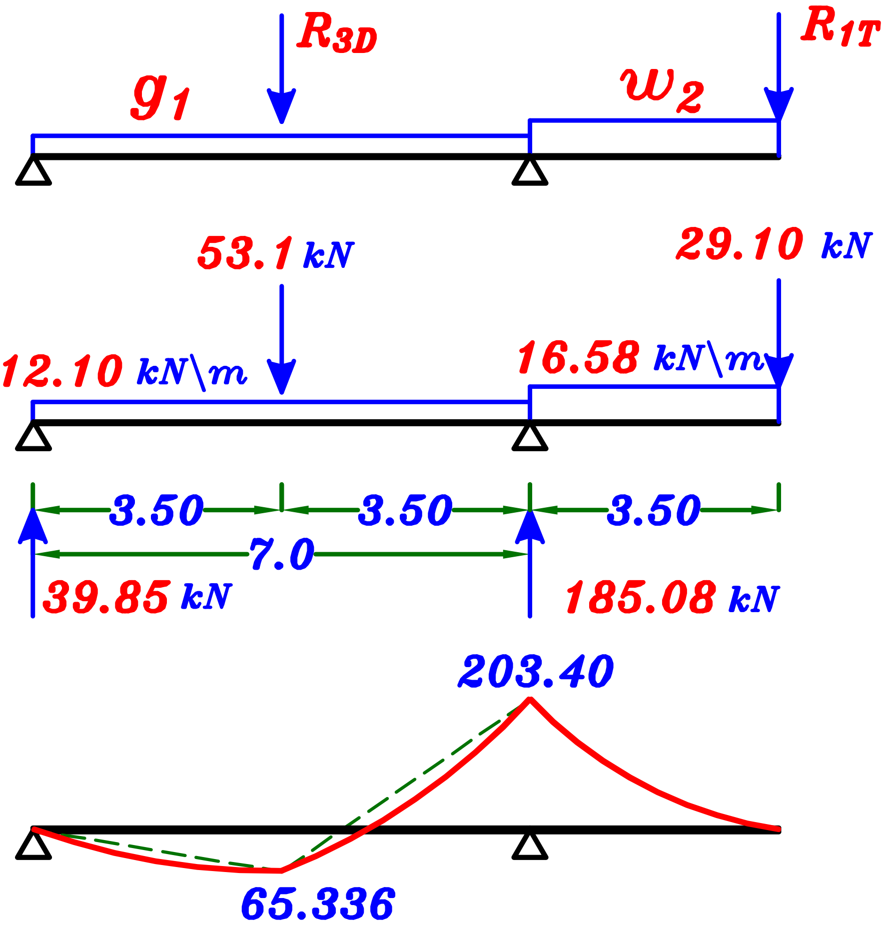
$$w_2 = g_2 + p_2 = 13.33 + 3.25 = 16.58\ kN\backslash m'$$

max–max B.M.D. For the girder (G_1)

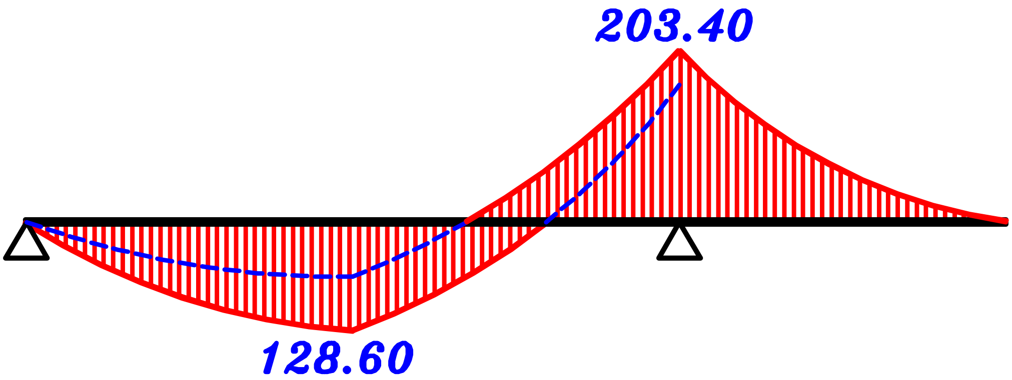
1- max. +Ve B.M.D.



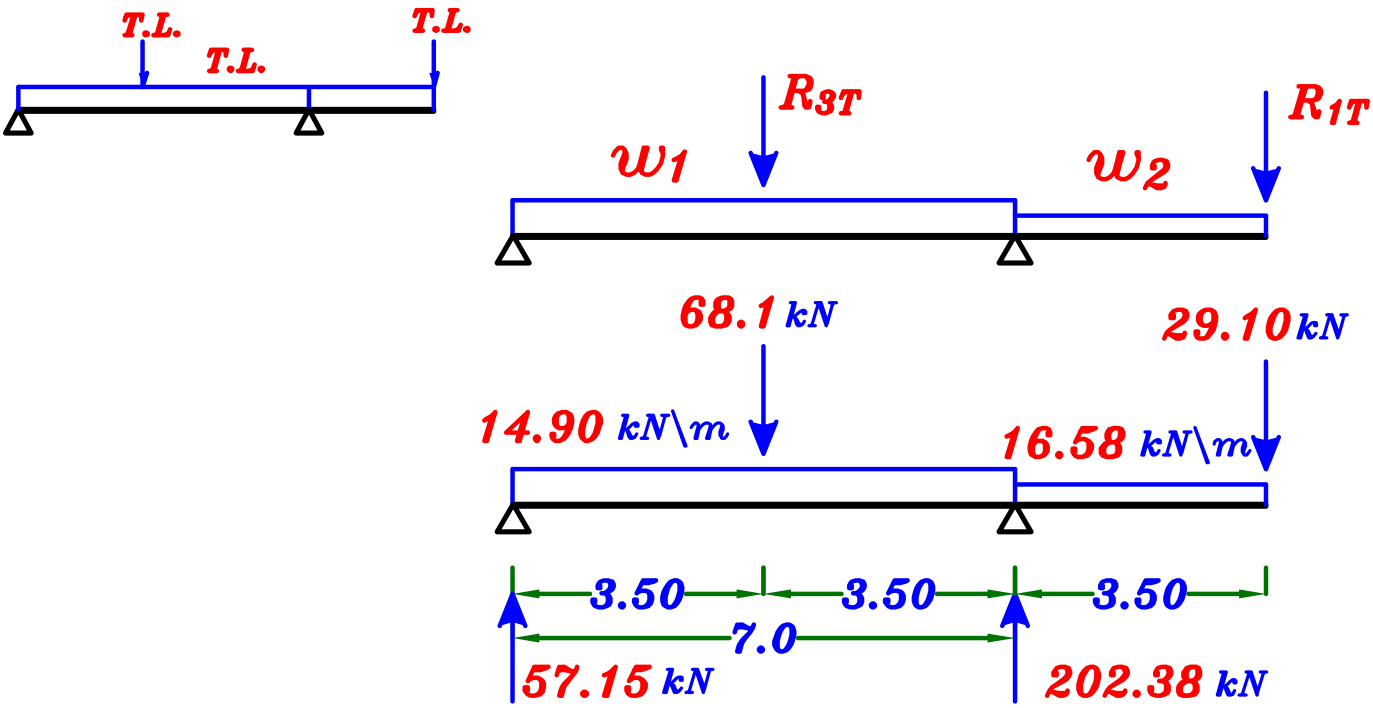
2- max. –Ve B.M.D.



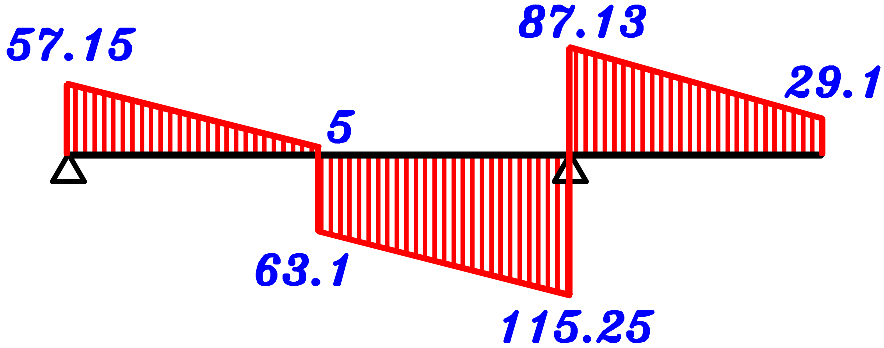
max–max B.M.D. For the girder (G_1)



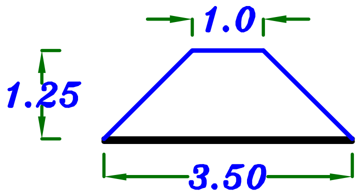
S.F.D. For the girder (G_1)



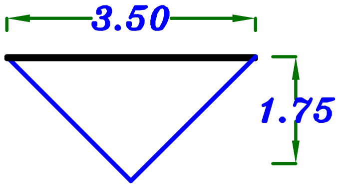
S.F.D.



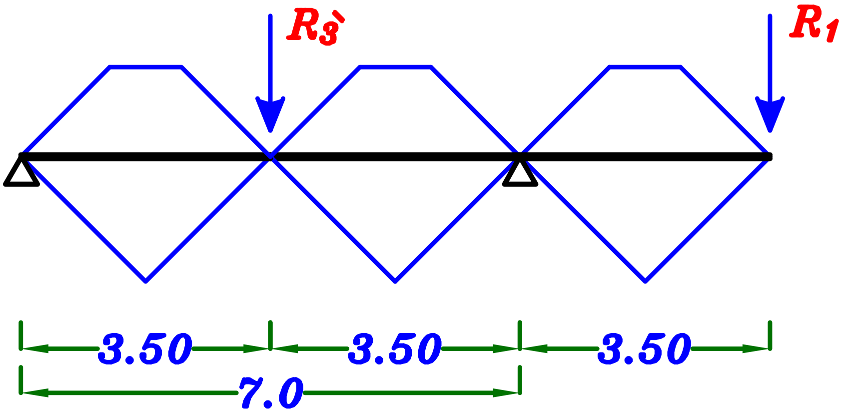
G_2 (250 * 700)

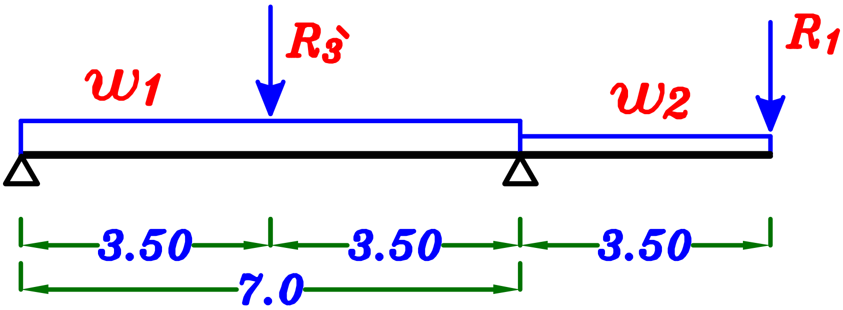


$area = 2.812\ m^2$

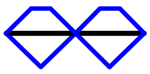


$area = 3.062\ m^2$





w_1



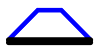
$$g_1 = O.W. + \frac{\sum area}{Span} * g_s$$

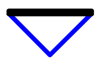
$$= 4.40 + \frac{2\,(2.812) + 2\,(3.062)}{7.0}\,(5.50) = 13.63\ kN\backslash m$$

$$p_1 = \frac{\sum area}{Span} * p_s = \frac{2\,(2.812) + 2\,(3.062)}{7.0}\,(2.0) = 3.35\ kN\backslash m$$

$$w_1 = g_1 + p_1 = 13.63 + 3.35 = 16.98\ kN\backslash m`$$

w_2





$$g_2 = O.W. + \frac{\sum area}{Span} * g_s + C_e\ g_s\ \frac{L_c}{2}$$

$$g_2 = 4.40 + \frac{(2.812)}{3.50}\,(5.50) + \frac{1}{2}\,(5.50)\left(\frac{3.50}{2}\right) = 13.63\ kN\backslash m$$

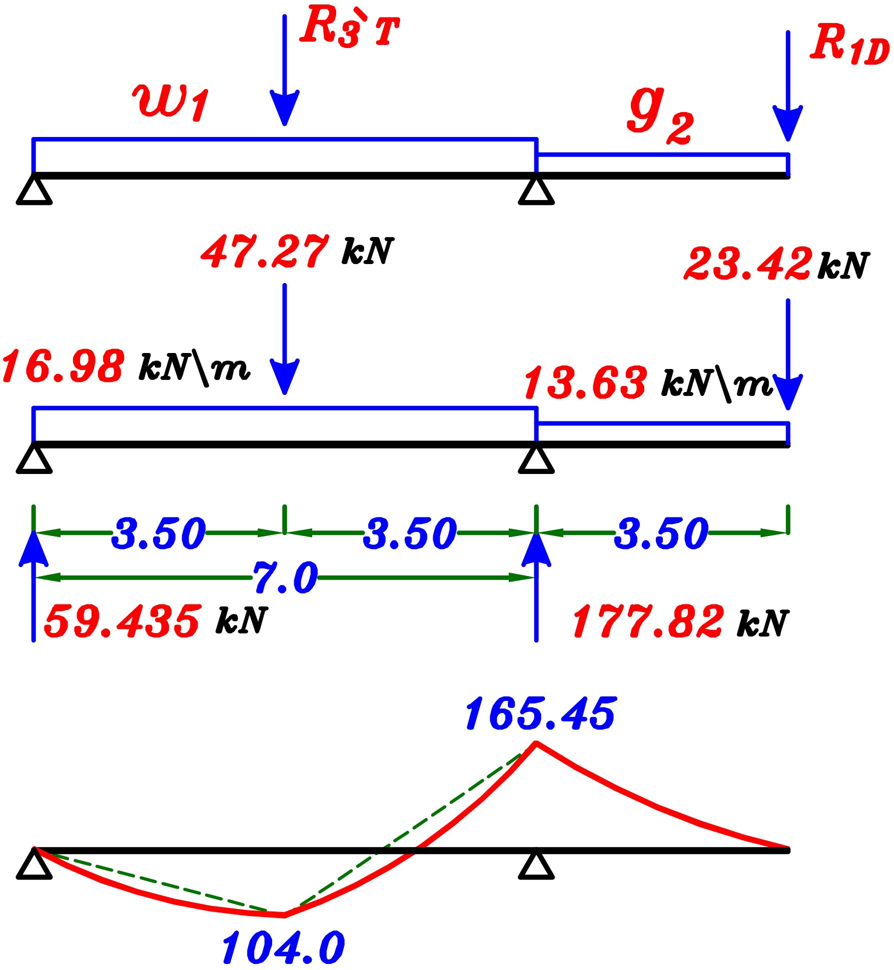
$$p_2 = \frac{\sum area}{Span} * p_s + C_e\ p_s\ \frac{L_c}{2}$$

$$= \frac{(2.812)}{3.50}\,(2.0) + \frac{1}{2}\,(2.0)\left(\frac{3.50}{2}\right) = 3.35\ kN\backslash m$$

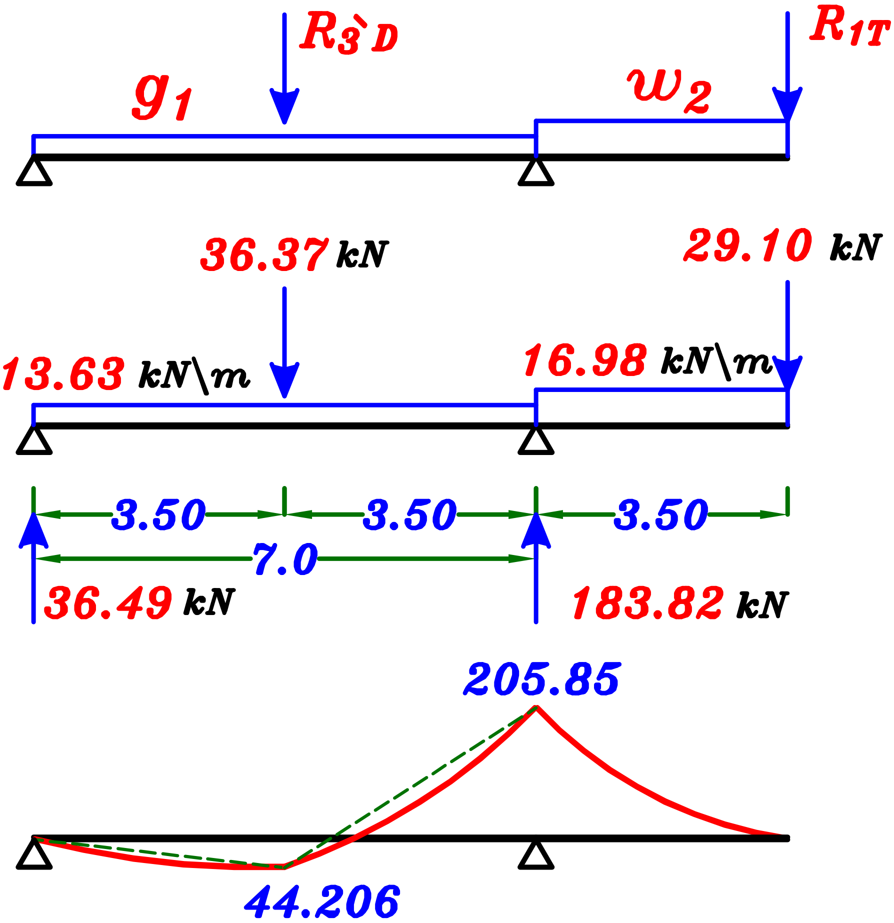
$$w_2 = g_2 + p_2 = 13.63 + 3.35 = 16.98\ kN\backslash m$$

max–max B.M.D.For the girder (G_2)

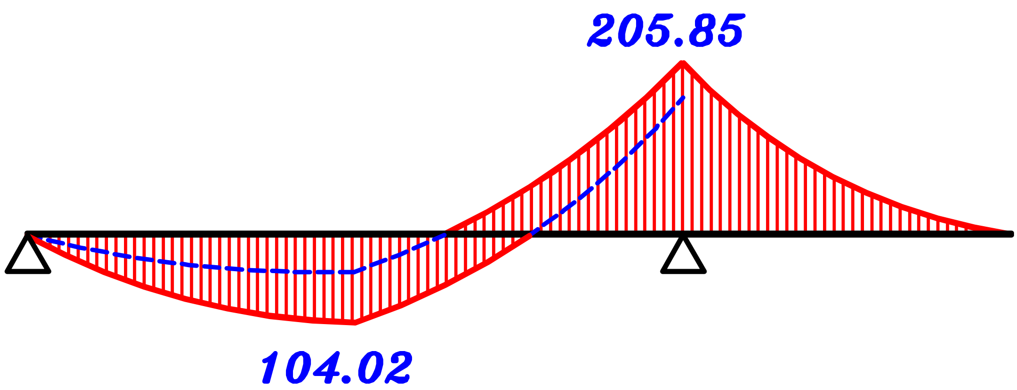
1- max. +Ve B.M.D.



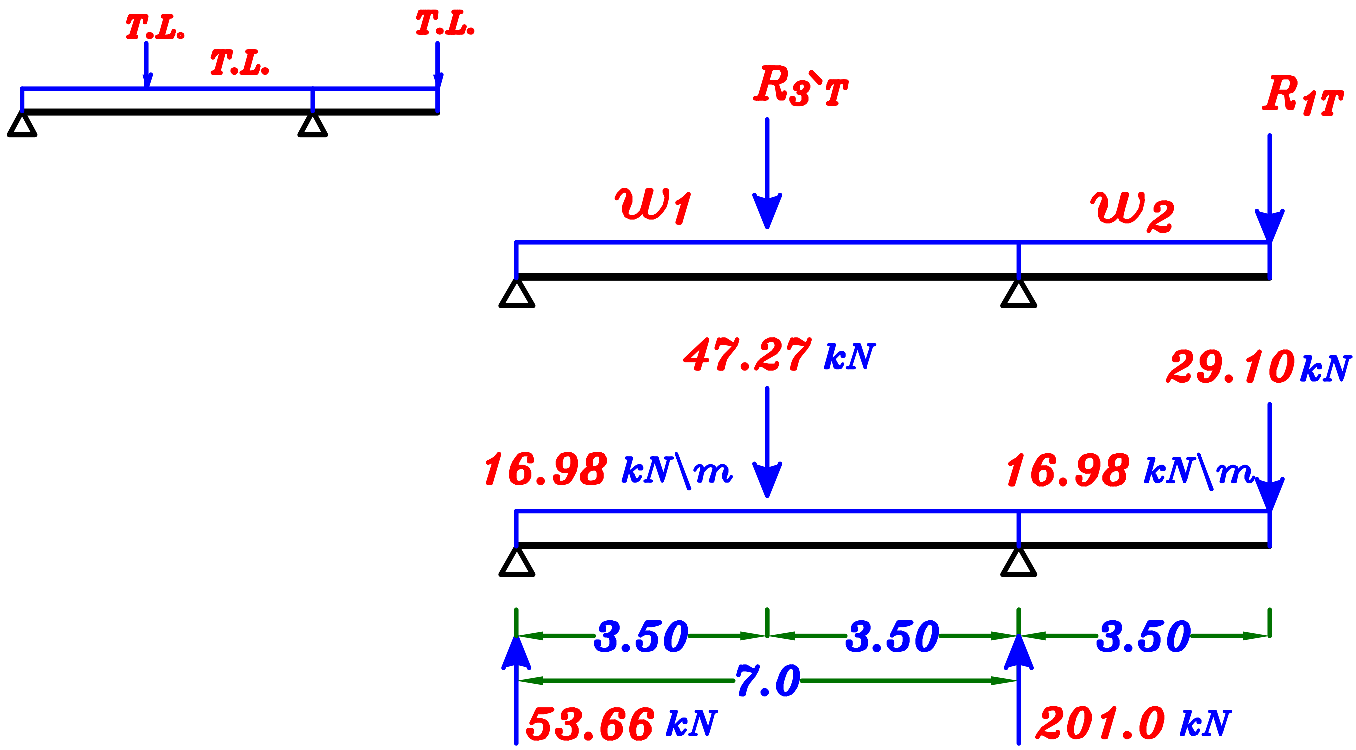
2- max. –Ve B.M.D.

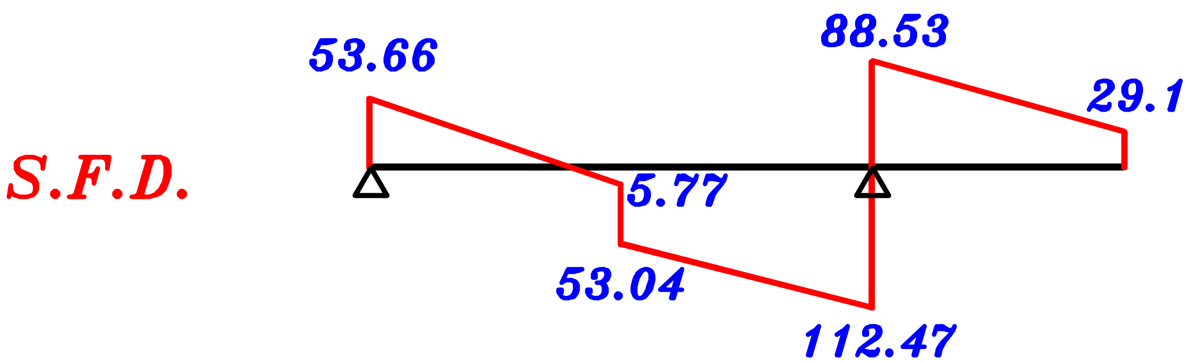


max–max B.M.D. For the girder (G_2)

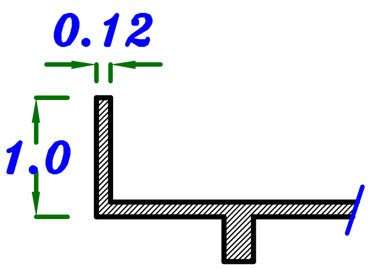


S.F.D. For the girder (G_2)

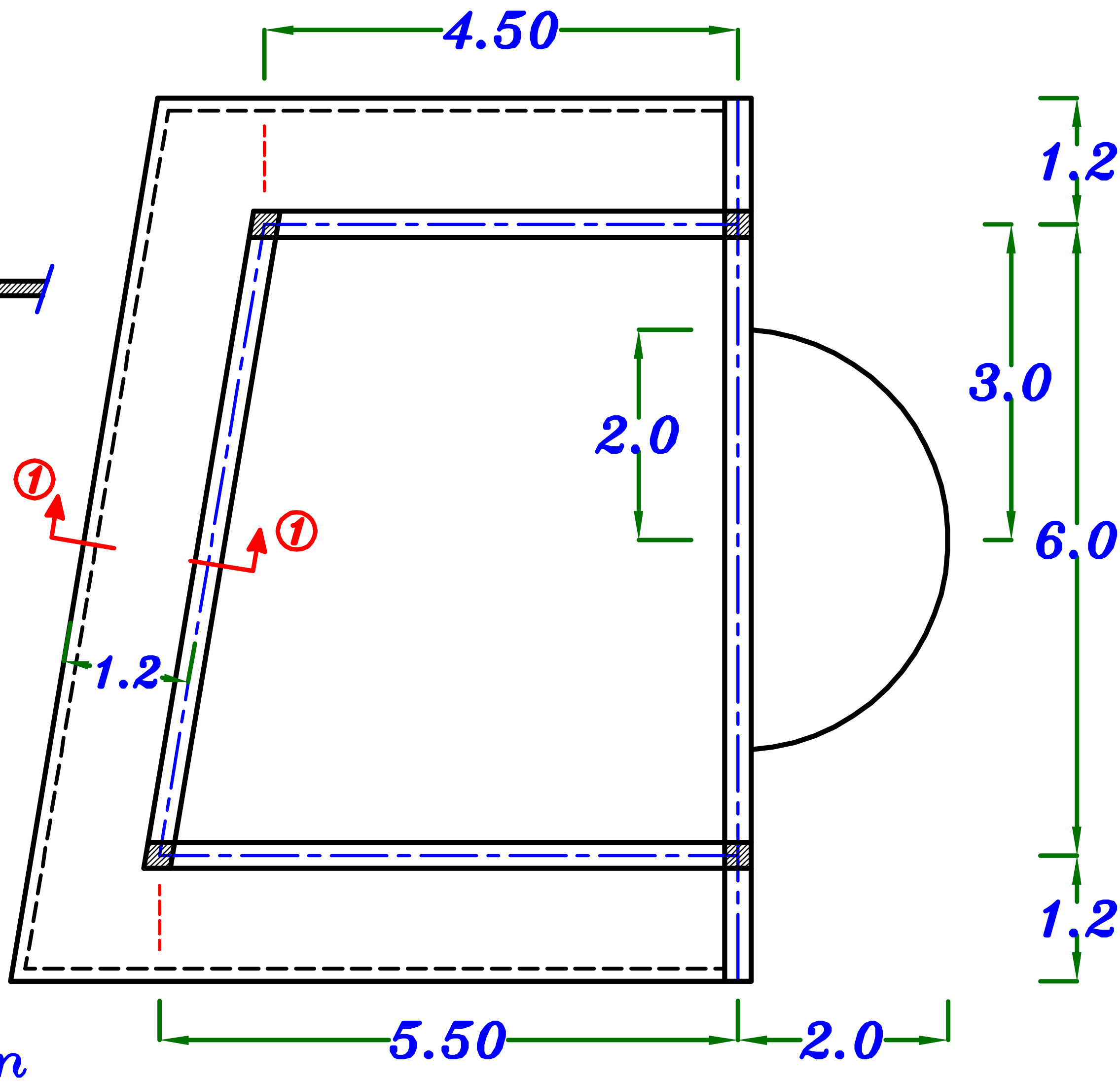




Example.



Sec. (1-1)



Data.

$t_s = 0.16\ m$

$F.C. = 1.50\ \ kN\backslash m^2$

$L.L. = 3.0\ \ kN\backslash m^2$

b (Beams & Girders) = 0.25 m

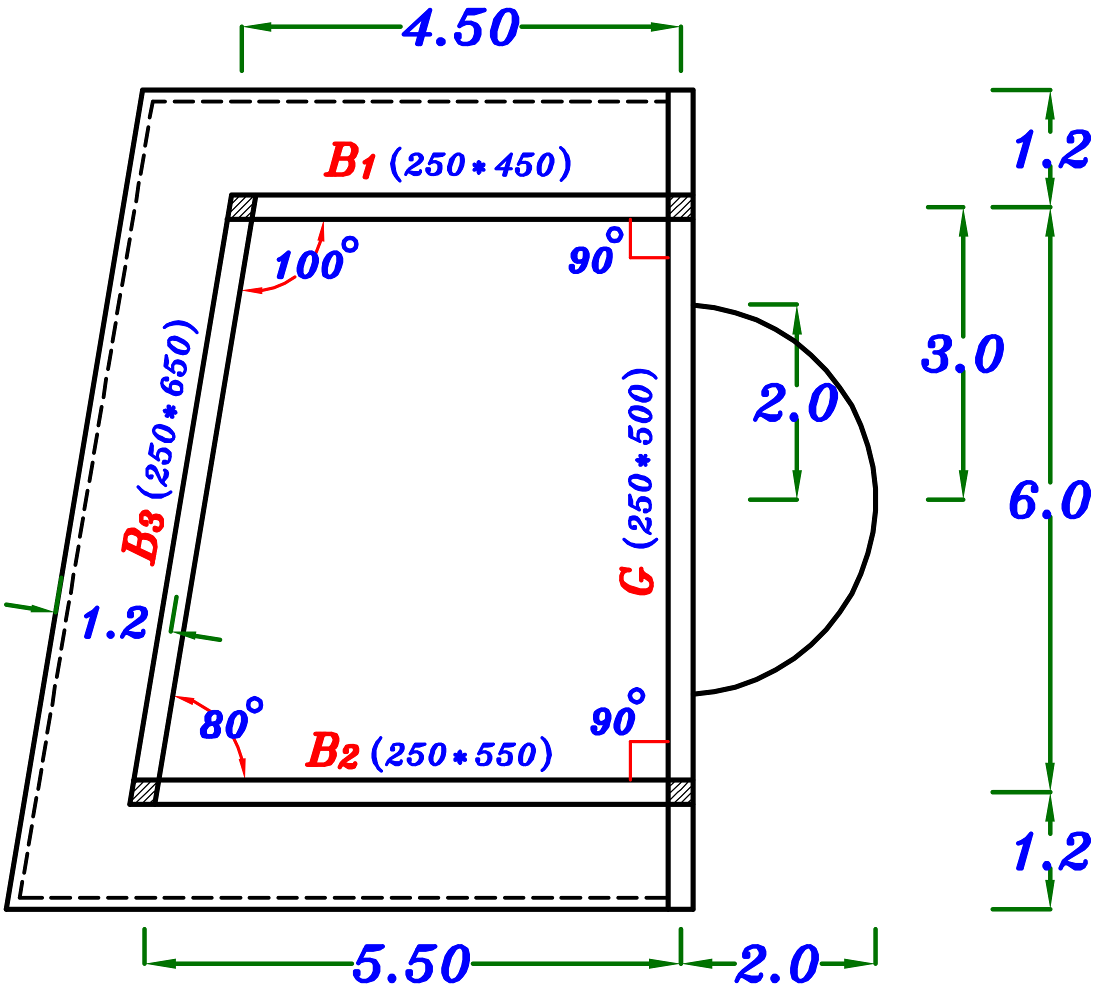
O.W. of beams & girders are reasonably assumed according to the expected depth.

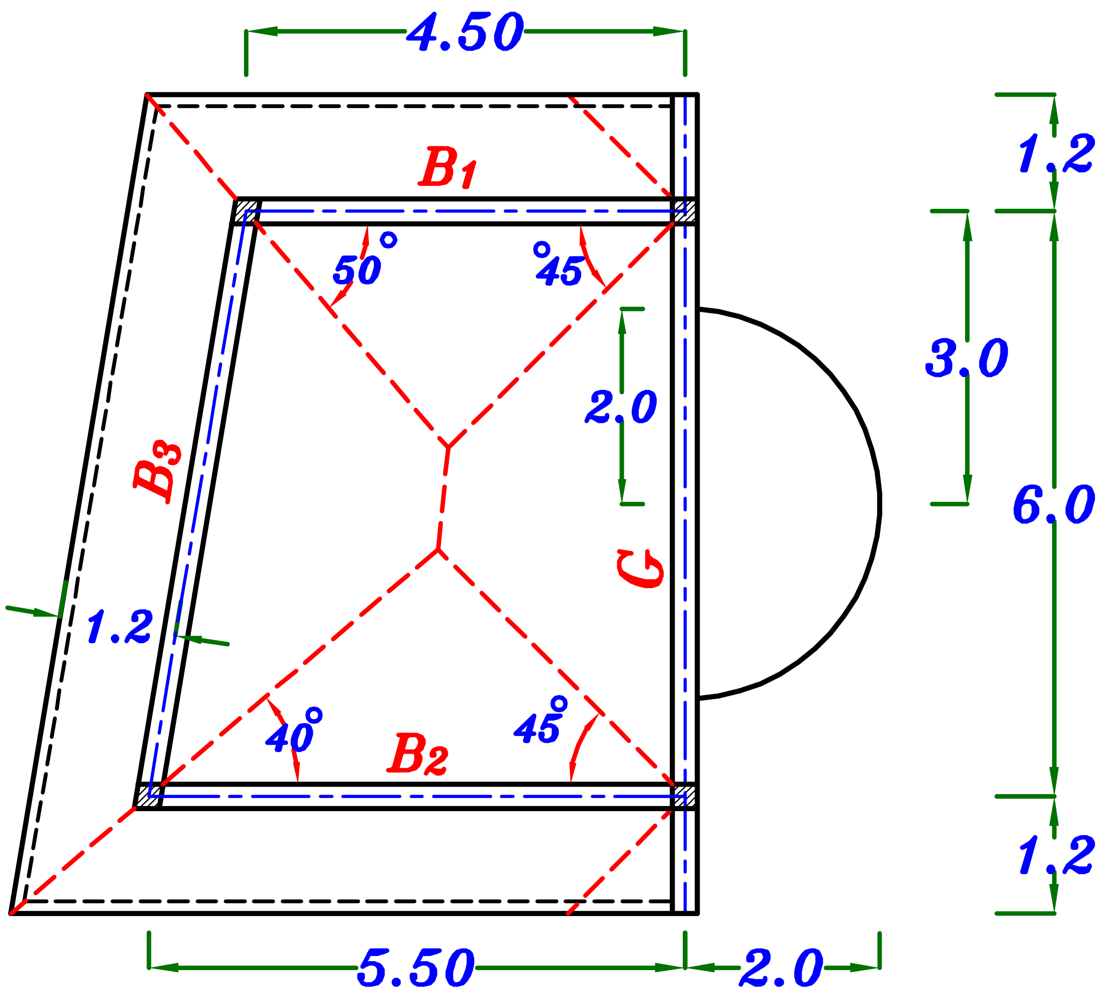
Req.

1- Draw the structural plan showing the pattern of Load Distribution.

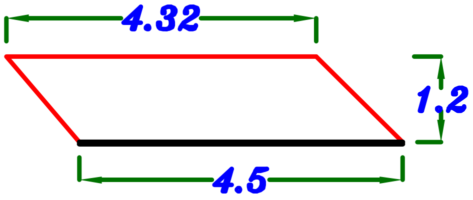
2- Calculate the equivalent load For shear and bending For all beams.

3- Draw S.F.D. & Absolute B.M.D. For the Girder.

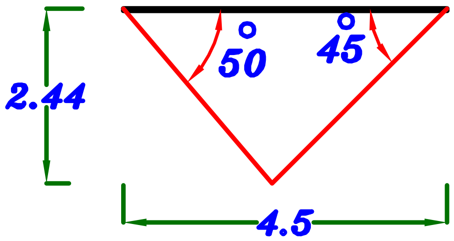

4.50
1.2
B1 (250*450)
100°
90°
3.0
2.0
B3 (250*650)
G (250*500)
6.0
1.2
80°
90°
B2 (250*550)
1.2
5.50
2.0


4.50
1.2
B1
50°
45°
3.0
2.0
B3
6.0
G
1.2
40°
45°
B2
1.2
5.50
2.0

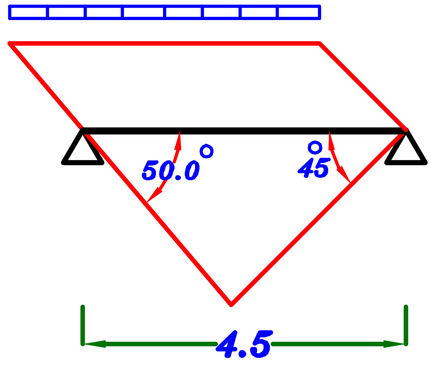
B_1

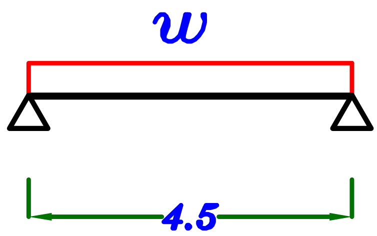


$area = 5.29\ m^2$



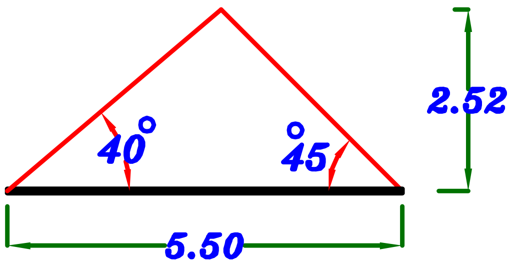
$area = 5.49\ m^2$



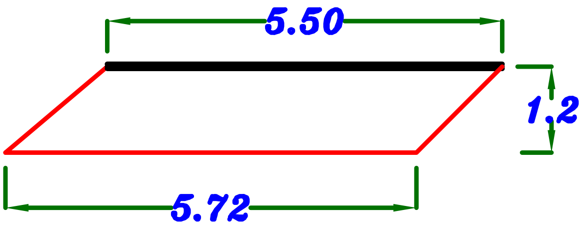


$$w = o.w + \frac{\sum area}{Span = 4.50\ m} * w_s + \frac{\sum weight = b\,h\,\gamma_c * 4.32\ m}{Span = 4.50\ m}$$

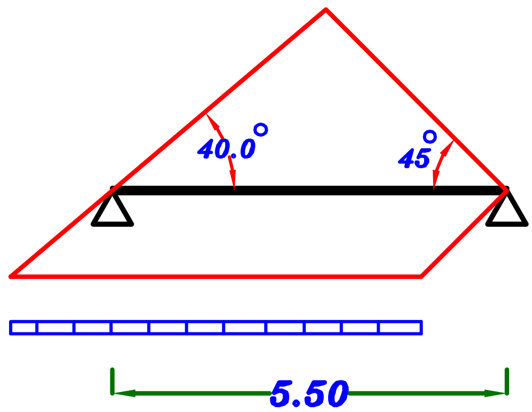
B_2

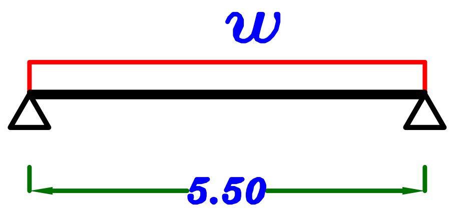


$area = 6.93\ m^2$



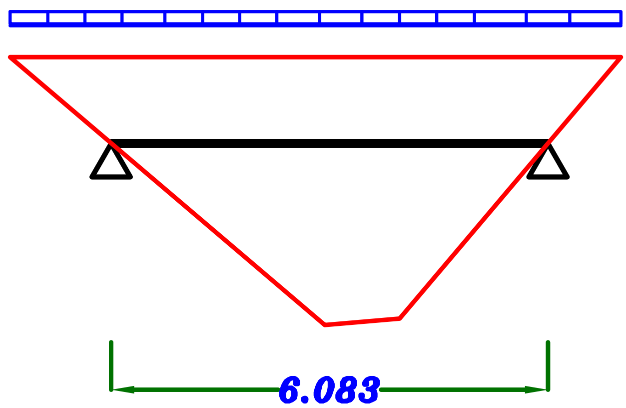
$area = 6.732\ m^2$

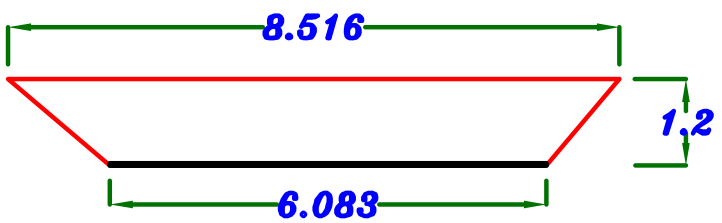




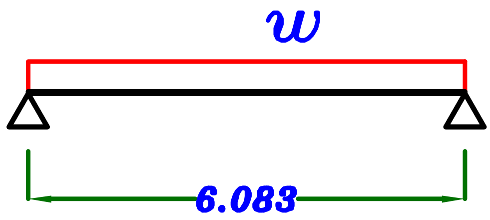
$$w = o.w + \frac{\sum area}{Span = 5.50\ m} * w_s + \frac{\sum weight = b\,h\,\gamma_c * 5.72\ m}{Span = 5.50\ m}$$

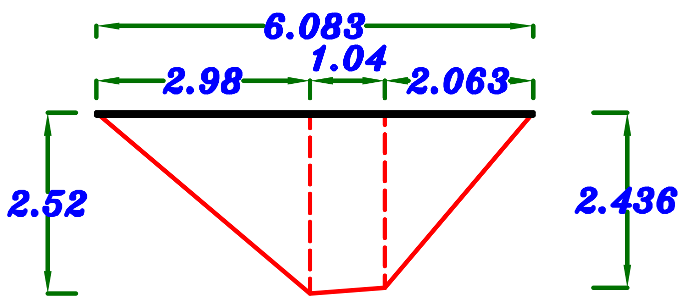
B_3





area = 8.759 m^2

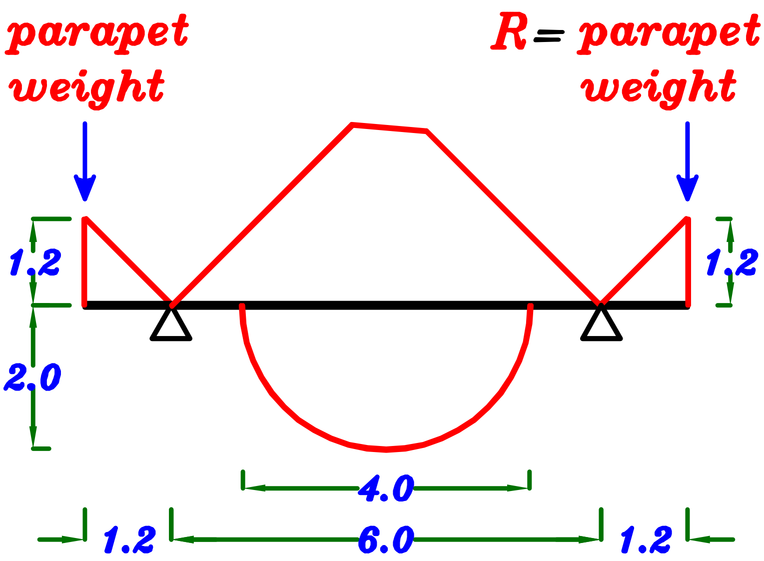




area = 8.844 m^2

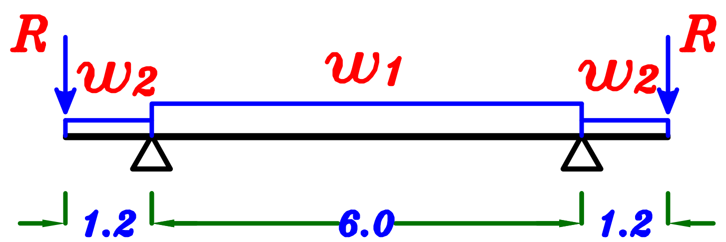
$$w = o.w + \frac{\sum area}{Span = 6.083\ m} * w_s + \frac{\sum weight = b\,h\,\gamma_c * 8.516\ m}{Span = 6.083\ m}$$

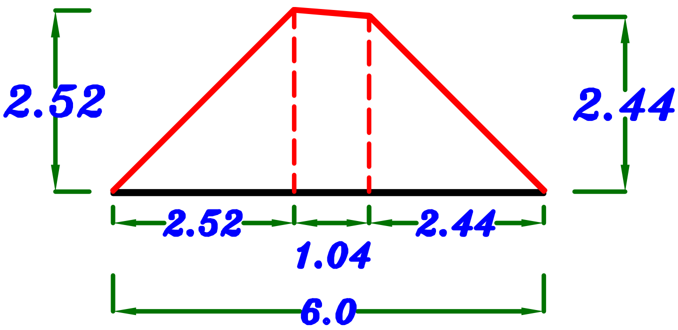
G



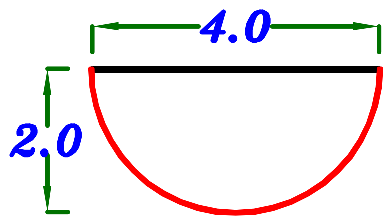
parapet weight

$$R = b\,h\,\gamma_c * 1.20\ m$$

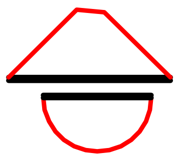




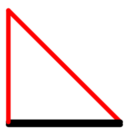
area = 8.731 m^2



area = 6.283 m^2

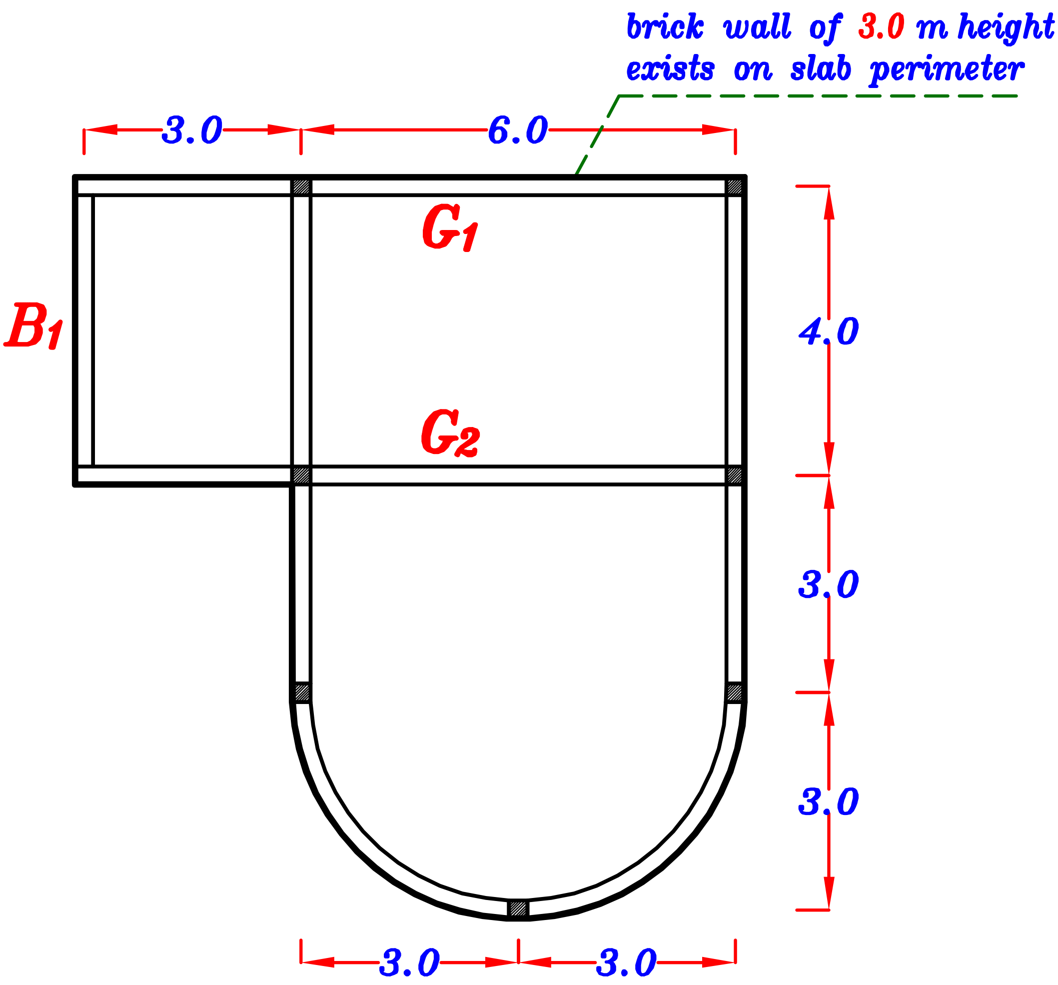


$$w_1 = o.w + \frac{\sum area}{Span = 6.0\ m} * w_s$$



$$w_2 = o.w + C_a\, w_s\, L_c$$

Example.

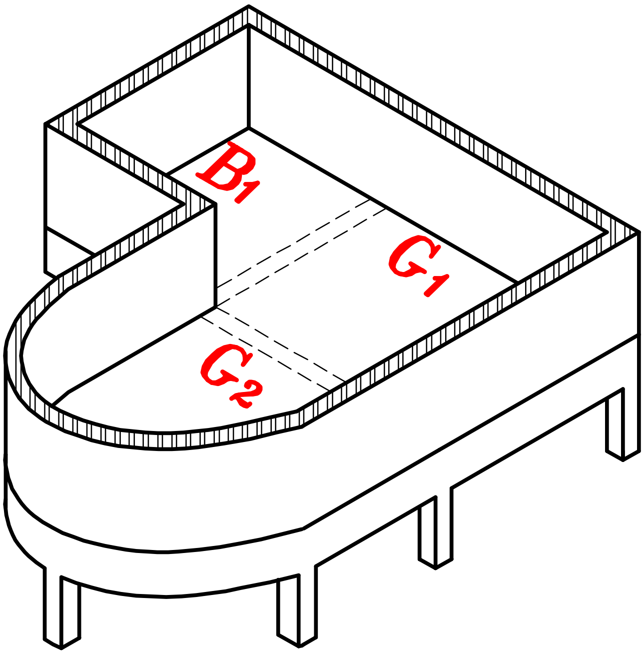


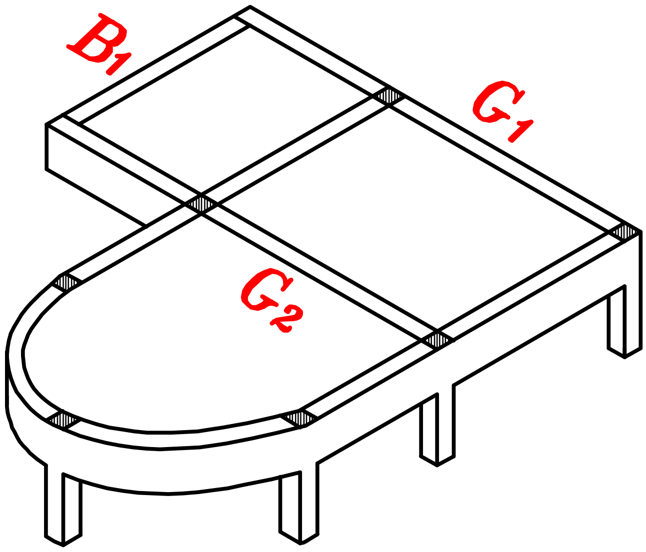
مطلوب حساب w_e , w_a لكل الكمرات .

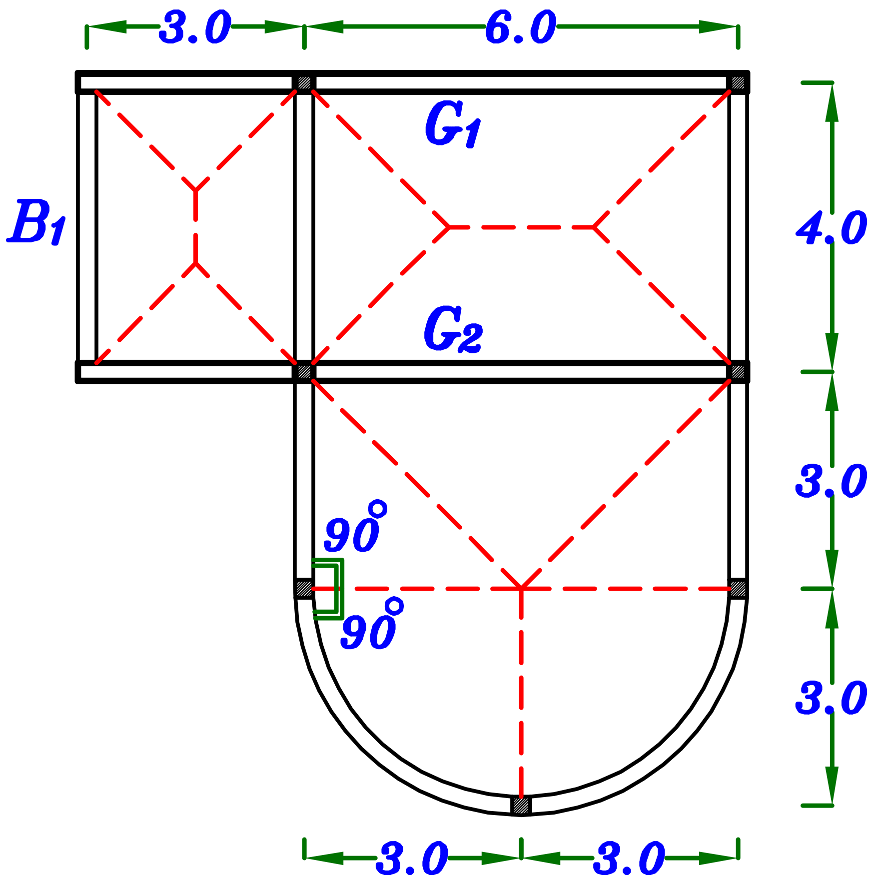
و مطلوب رسم max-max B.M.D. للـ girder G_1 , G_2

لذا سنحسب الـ Reactions فقط للكمرات المحموله على الـ Girders

الحائط على المحيط الخارجي فقط







$F.C. = 2.0 \ kN\backslash m^2$

$L.L. = 2.0 \ kN\backslash m^2$

$\gamma_{wall} = 18.0 \ kN\backslash m^3$

$b_{wall} = 0.25 \ m$

$H_{wall} = 3.0 \ m$

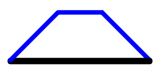
$$g_s = t_s * \gamma_c + F.C. = 0.16 * 25 + 2.0 = 6.0 \ kN\backslash m^2$$

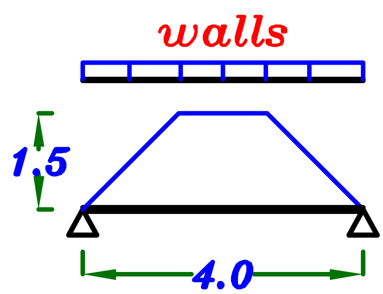
$$p_s = L.L. = 2.0 \ kN\backslash m^2$$

B_1

$$b * h_w * \gamma_w$$

$$0.25 * 3.0 * 18.0$$

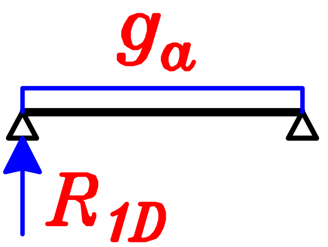


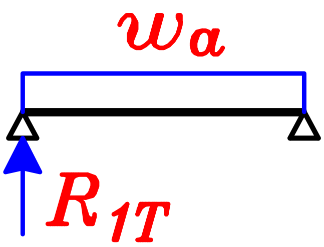


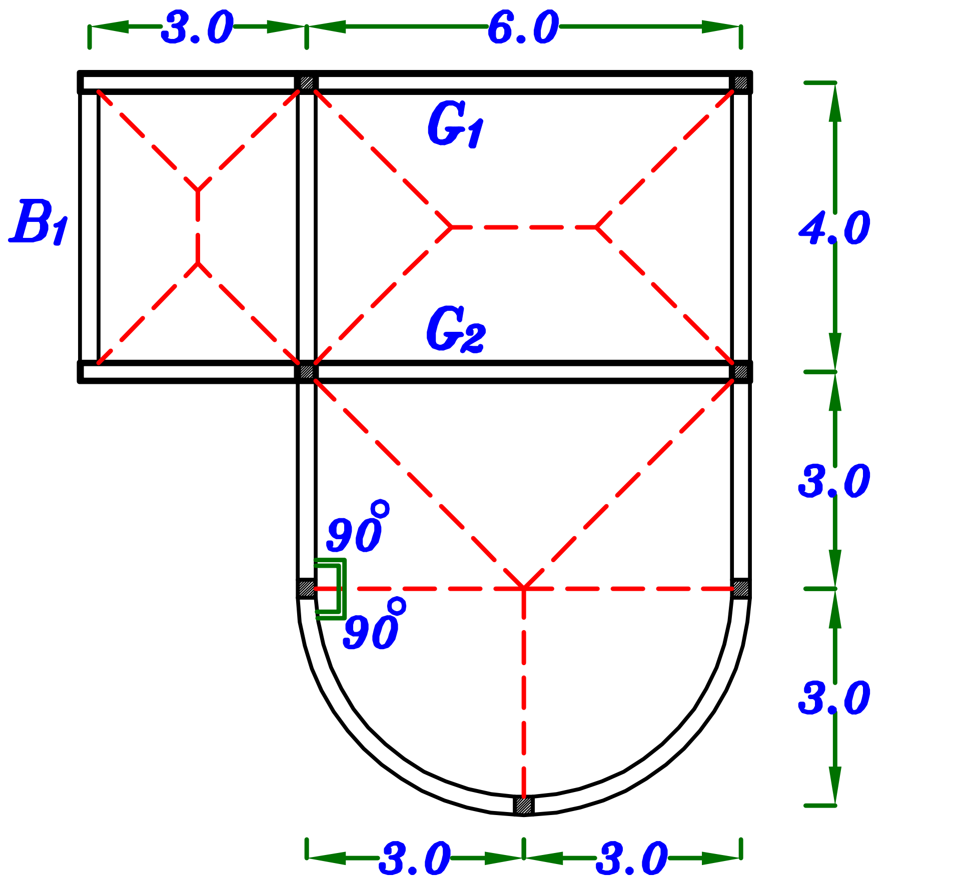
$$g_a = o.w. + walls + C_a * g_s * \frac{L_s}{2}$$

$$p_a = C_a * p_s * \frac{L_s}{2}$$

$$w_a = g_a + p_a$$







$\underline{\underline{G_1}}$

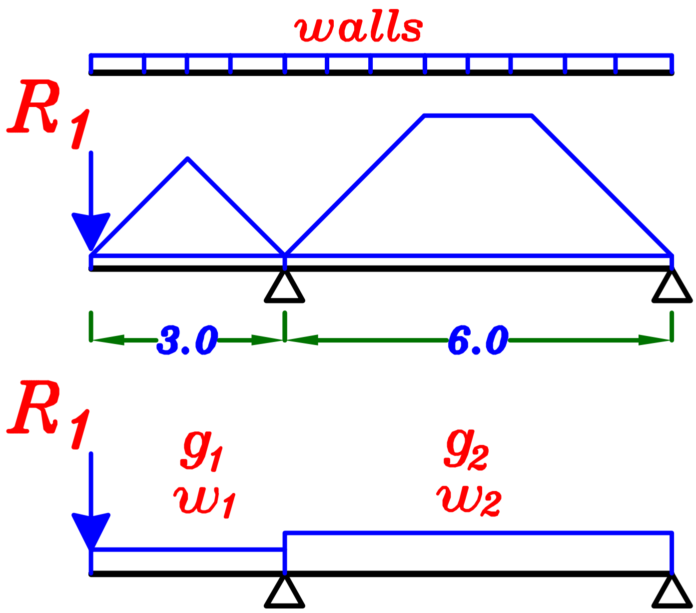
$$b * h_w * \gamma_w$$

$$0.25 * 3.0 * 18.0$$

$$g_1 = o.w. + wall + C_e\, g_s * \frac{Lc}{2}$$

$$p_1 = C_e\, p_s * \frac{Lc}{2}$$

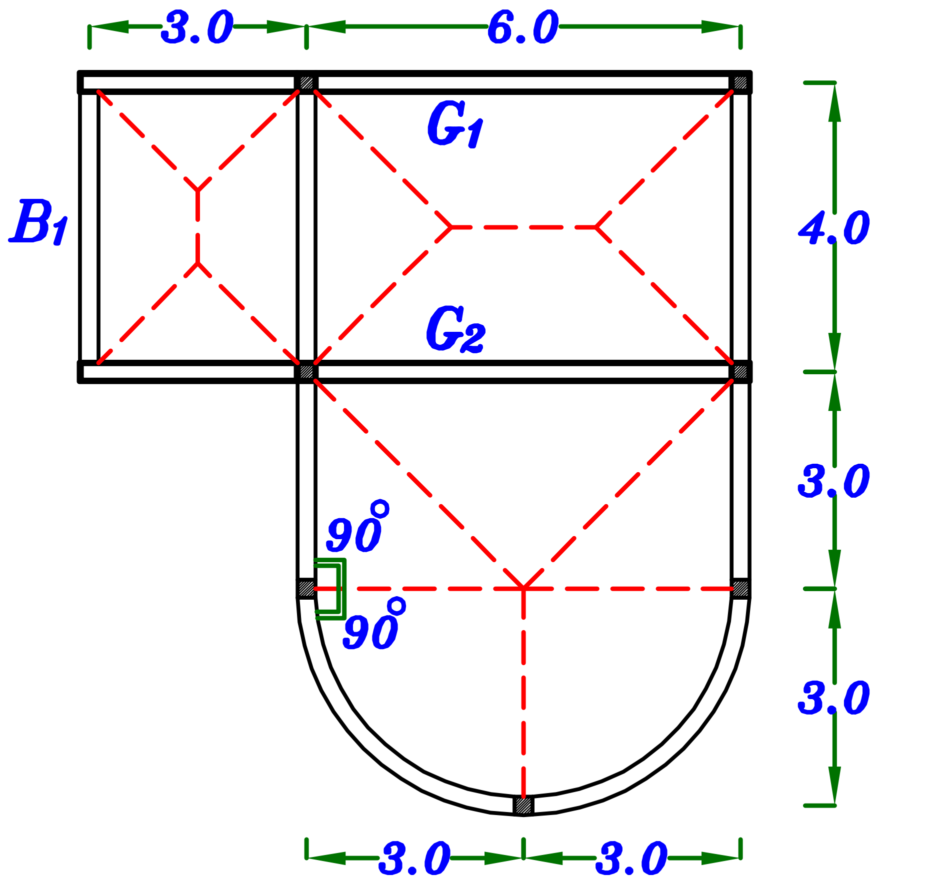
$$w_1 = g_1 + p_1$$



$$g_2 = o.w. + wall + C_e\, g_s * \frac{Ls}{2}$$

$$p_2 = C_e\, p_s * \frac{Ls}{2}$$

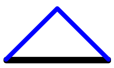
$$w_2 = g_2 + p_2$$

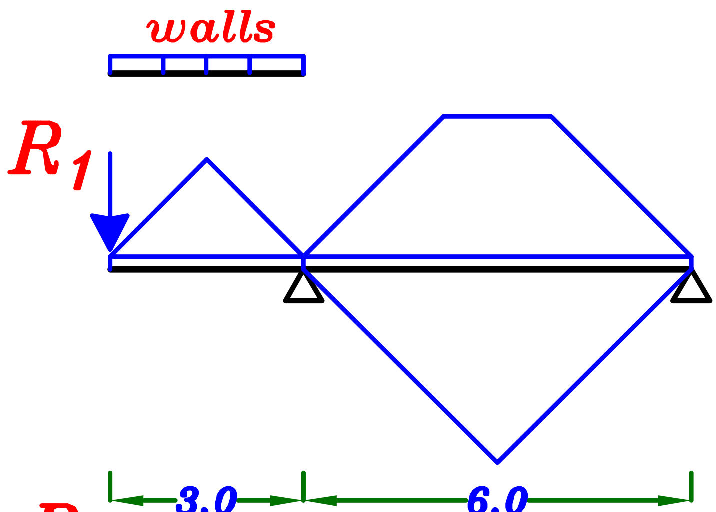


$\underline{\underline{G_2}}$

$$b * h_w * \gamma_w$$

$$0.25 * 3.0 * 18.0$$

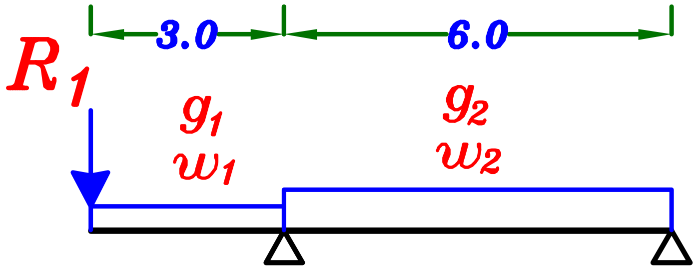


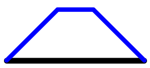


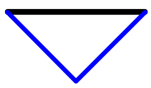
$$g_1 = o.w. + wall + C_e\ g_s * \frac{Lc}{2}$$

$$p_1 = C_e\ p_s * \frac{Lc}{2}$$

$$w_1 = g_1 + p_1$$





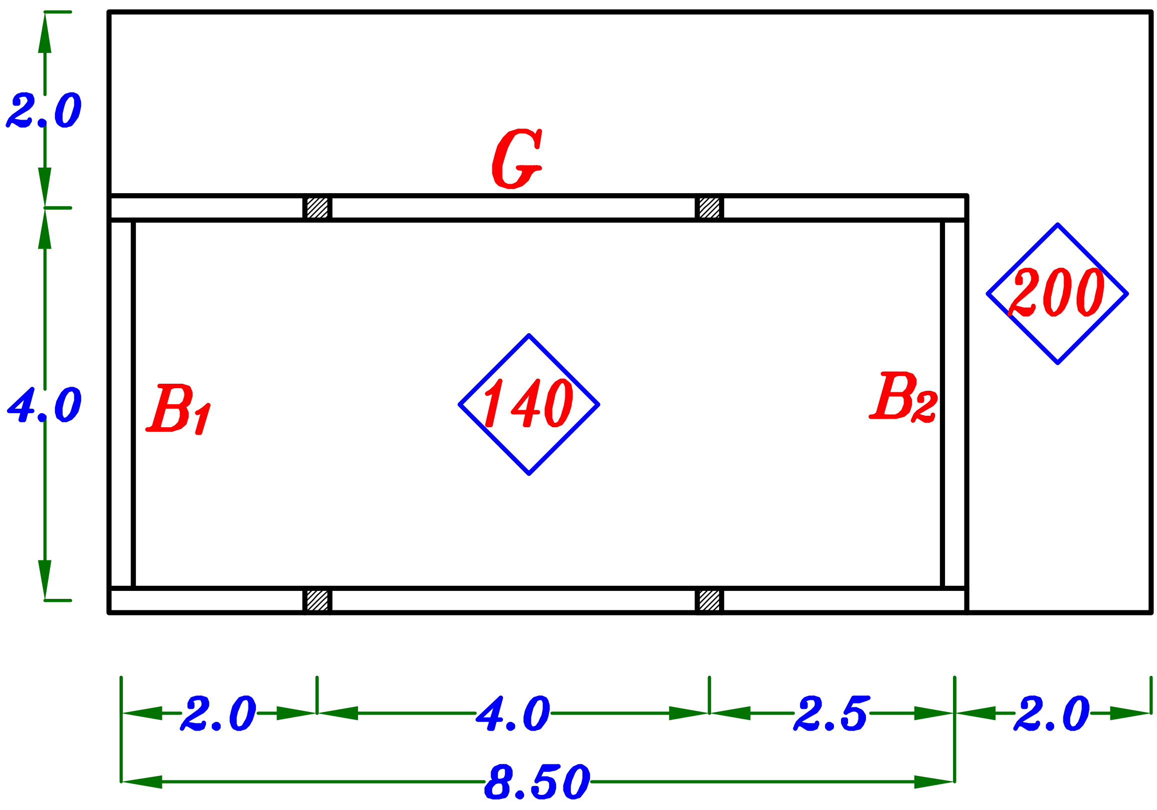


$$g_2 = o.w. + C_e\ g_s * \frac{Ls}{2} + C_e\ g_s * H$$

$$p_2 = C_e\ p_s * \frac{Ls}{2} + C_e\ p_s * H$$

$$w_2 = g_2 + p_2$$

Example.



$F.C. = 1.5 \; kN\backslash m^2$

$L.L. = 2.0 \; kN\backslash m^2$

For $t_s = 140$ mm

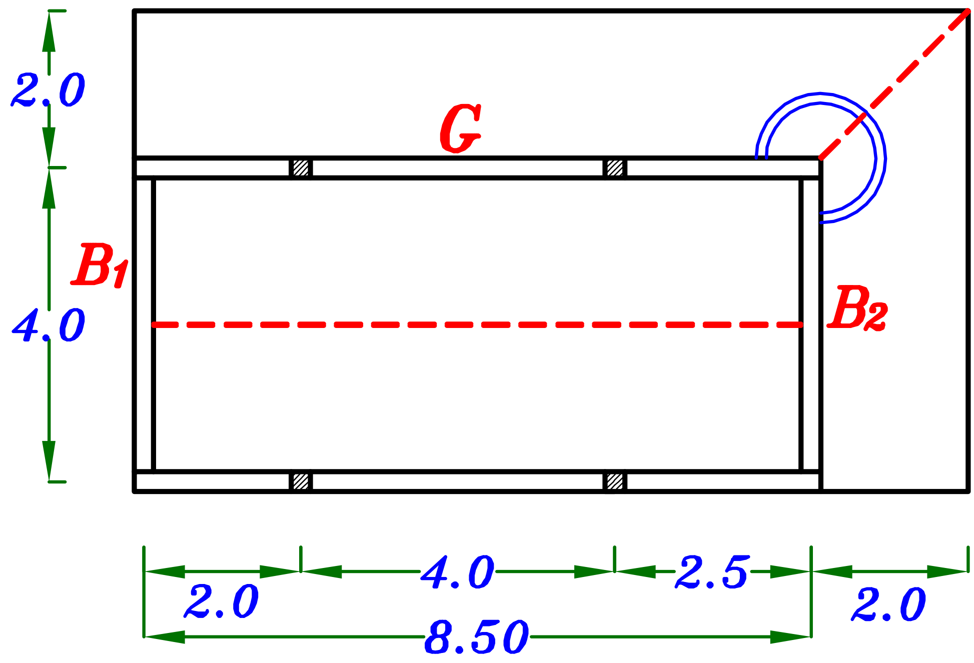
$$g_{s1} = t_{s1} * \gamma_c + F.C. = 0.14 * 25 + 1.50 = 5.0 \; kN\backslash m^2$$

$$p_s = L.L. = 2.0 \; kN\backslash m^2$$

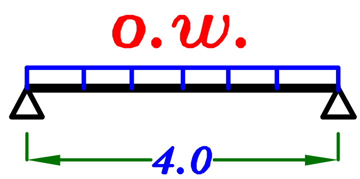
For $t_s = 200$ mm

$$g_{s2} = t_{s2} * \gamma_c + F.C. = 0.20 * 25 + 1.50 = 6.50 \; kN\backslash m^2$$

$$p_s = L.L. = 2.0 \; kN\backslash m^2$$

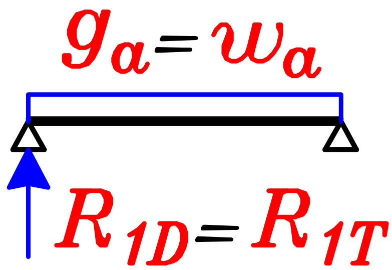


B_1

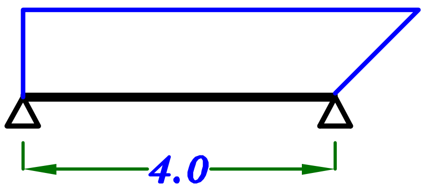


$$g_a = o.w. \qquad p_a = zero$$

$$w_a = g_a + p_a = g_a$$



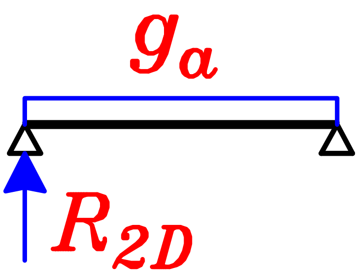
B_2

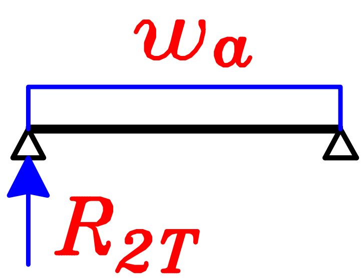


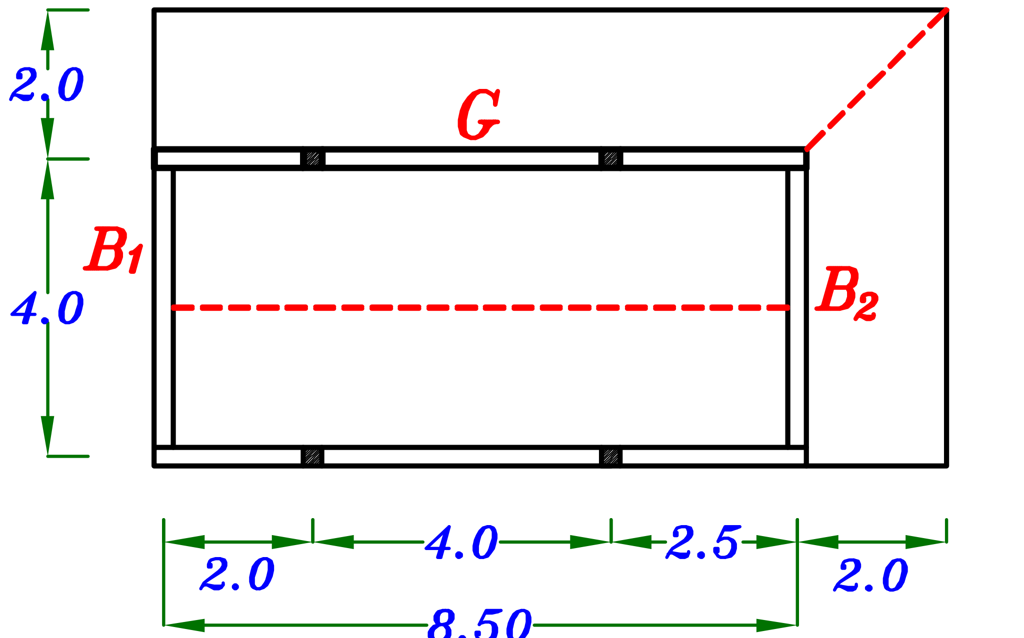
$$g_a = o.w. + \frac{\Sigma\, area}{Span} * g_{s2}$$

$$p_a = \frac{\Sigma\, area}{Span} * p_s$$

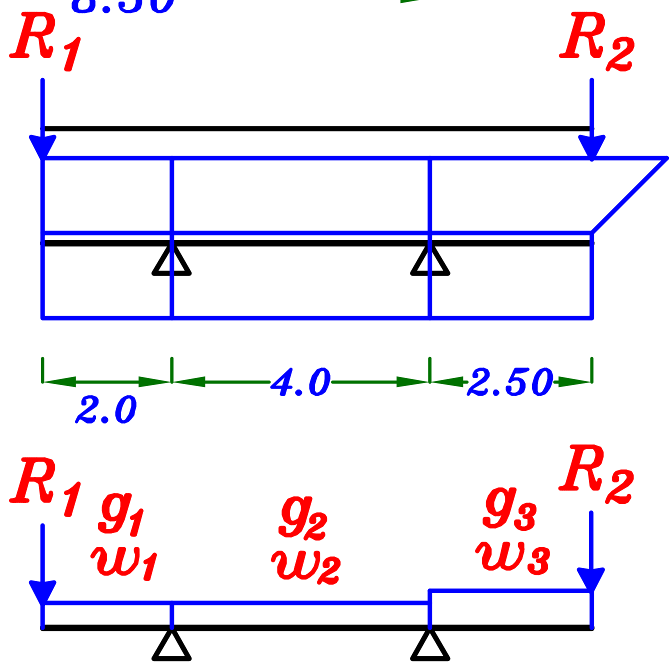
$$w_a = g_a + p_a$$







G



$$g_1 = g_2 = o.w. + g_{s1} * \frac{L_s}{2} + g_{s2} * L_c$$

$$p_1 = p_2 = \quad p_s * \frac{L_s}{2} + p_s * L_c$$

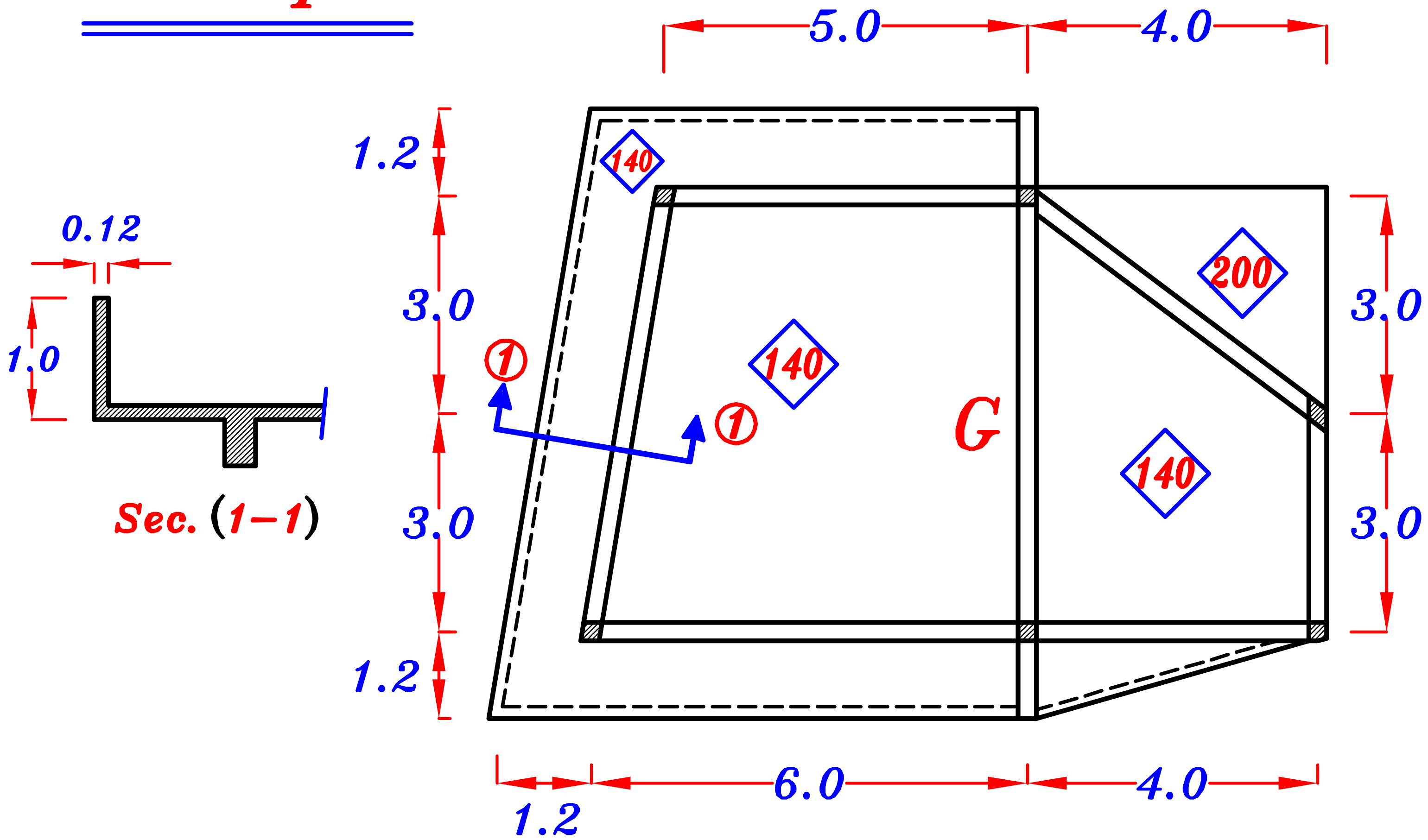
$$w_1 = w_2 = g_1 + p_1$$

$$g_3 = o.w. + g_{s1} * \frac{L_s}{2} + \frac{\sum area}{Span} * g_{s2}$$

$$p_3 = \quad p_s * \frac{L_s}{2} + \frac{\sum area}{Span} * p_s$$

$$w_3 = g_3 + p_3$$

Example.



$F.C. = 1.5\ kN\backslash m^2$

$L.L. = 3.0\ kN\backslash m^2$

Fence weight $= b\, h\, \gamma_c$

$= 0.12 * 1.0 * 25\ (kN/m')$

For $t_s = 140\ mm$

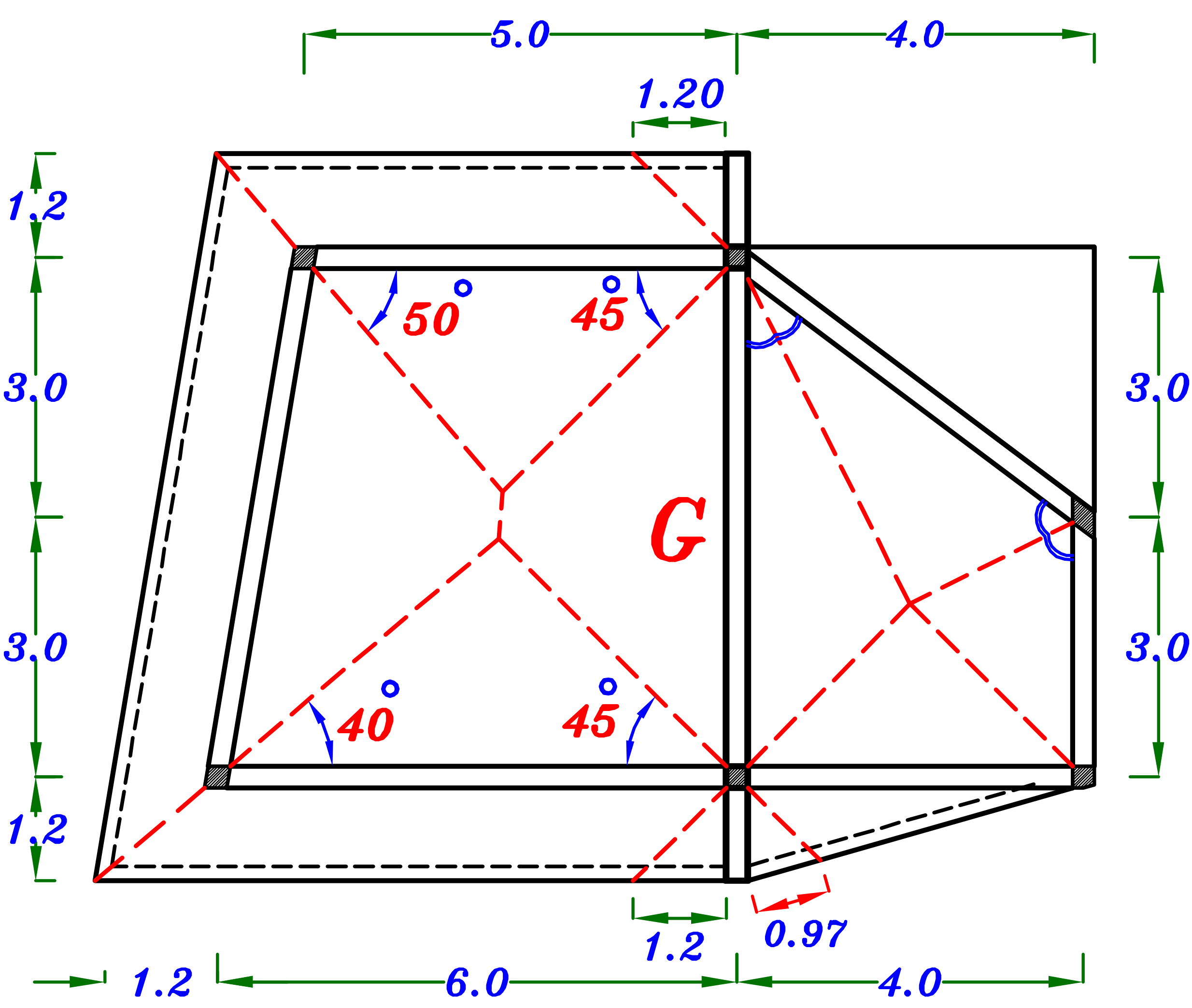
$g_{s1} = t_{s1} * \gamma_c + F.C. = 0.14 * 25 + 1.50 = 5.0\ kN\backslash m^2$

$p_s = L.L. = 3.0\ kN\backslash m^2$

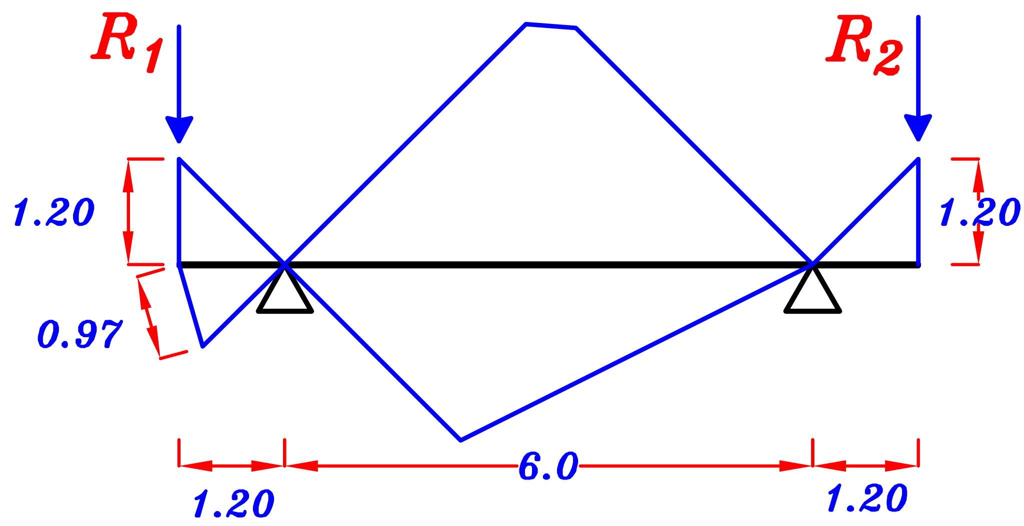
For $t_s = 200\ mm$

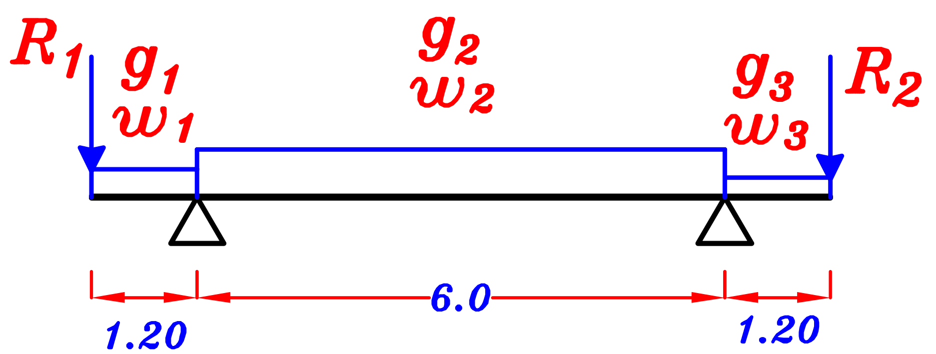
$g_{s2} = t_{s2} * \gamma_c + F.C. = 0.20 * 25 + 1.50 = 6.50\ kN\backslash m^2$

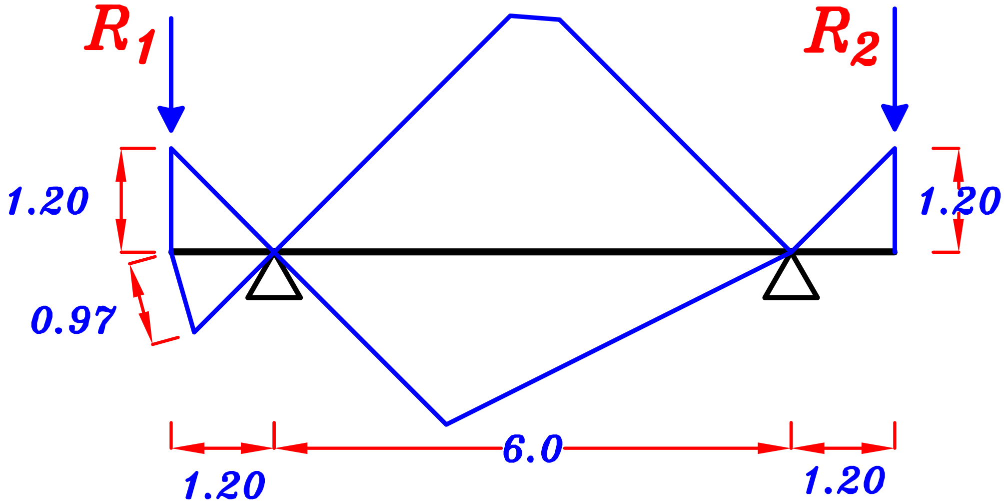
$p_s = L.L. = 3.0\ kN\backslash m^2$

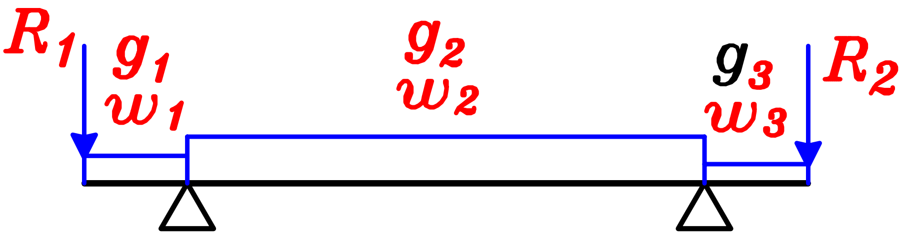


ممكن قياس اى بعد من على الرسمه اذا كانت مرسومه to scale

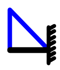
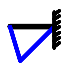








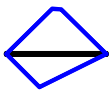
$$R_1 = b\,h\,\gamma_c * (1.2 + 0.97) \quad , \quad R_2 = b\,h\,\gamma_c * (1.2)$$

$$g_1 = o.w. + C_e\, g_{s1} * L_c + \frac{\sum area}{Span} * g_{s1}$$

$$p_1 = C_e\, p_s * L_c + \frac{\sum area}{Span} * p_s$$

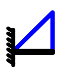
$$w_1 = g_1 + p_1$$



$$g_2 = o.w. + \frac{\sum area}{Span} * g_{s1}$$

$$p_2 = \frac{\sum area}{Span} * p_s$$

$$w_2 = g_2 + p_2$$

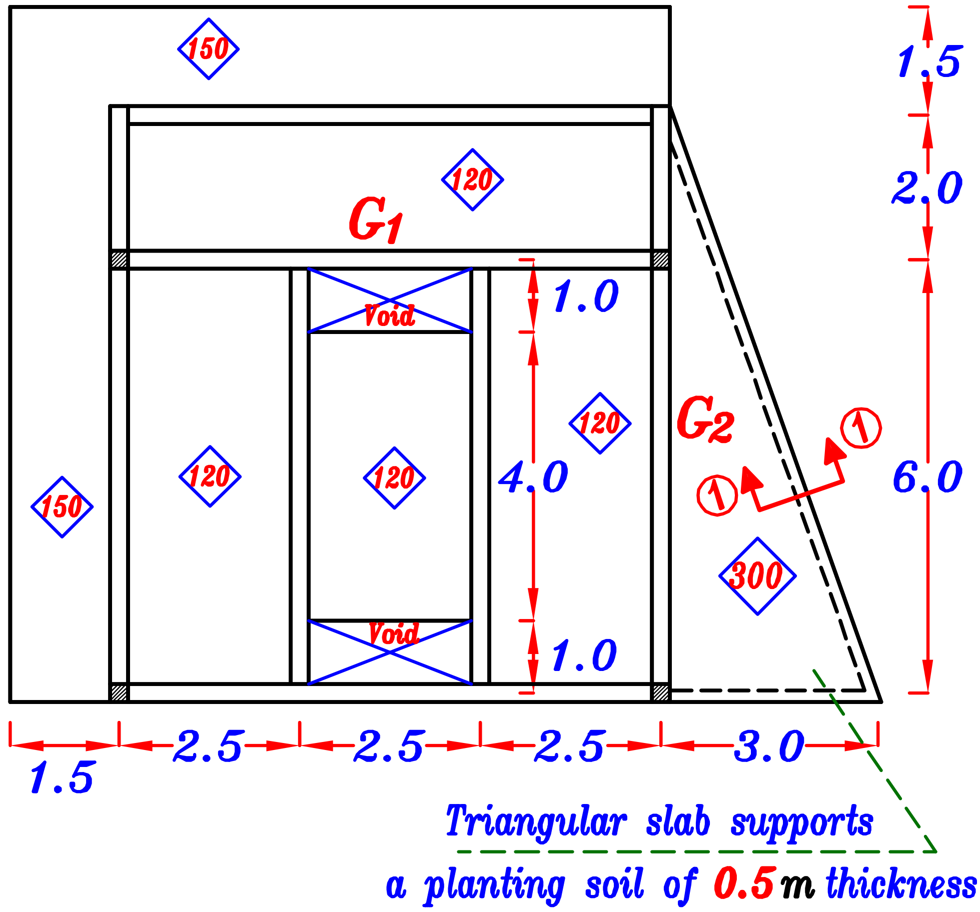


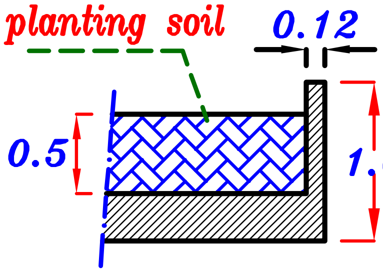
$$g_3 = o.w. + C_e\, g_{s1} * L_c$$

$$p_3 = C_e\, p_s * L_c$$

$$w_3 = g_3 + p_3$$

Example.





Sec. (1–1)

$$\gamma_{soil} = 20 \ kN/m^3$$

$$F.C. = 1.5 \ kN\backslash m^2$$

$$L.L. = 3.0 \ kN\backslash m^2$$

$$\text{Fence weight} = b\,h\,\gamma_c = 0.12 * 1.0 * 25 \ (kN/m')$$

For $t_s = 120$ mm

$$g_{s1} = t_{s1} * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.5 \ kN\backslash m^2$$

$$p_s = L.L. = 3.0 \ kN\backslash m^2$$

For $t_s = 150$ mm

$$g_{s2} = t_{s2} * \gamma_c + F.C. = 0.15 * 25 + 1.50 = 5.25 \ kN\backslash m^2$$

$$p_s = L.L. = 3.0 \ kN\backslash m^2$$

For $t_s = 300$ mm

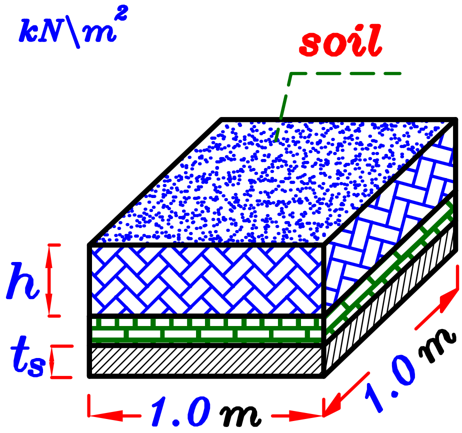
عزل رطوبه

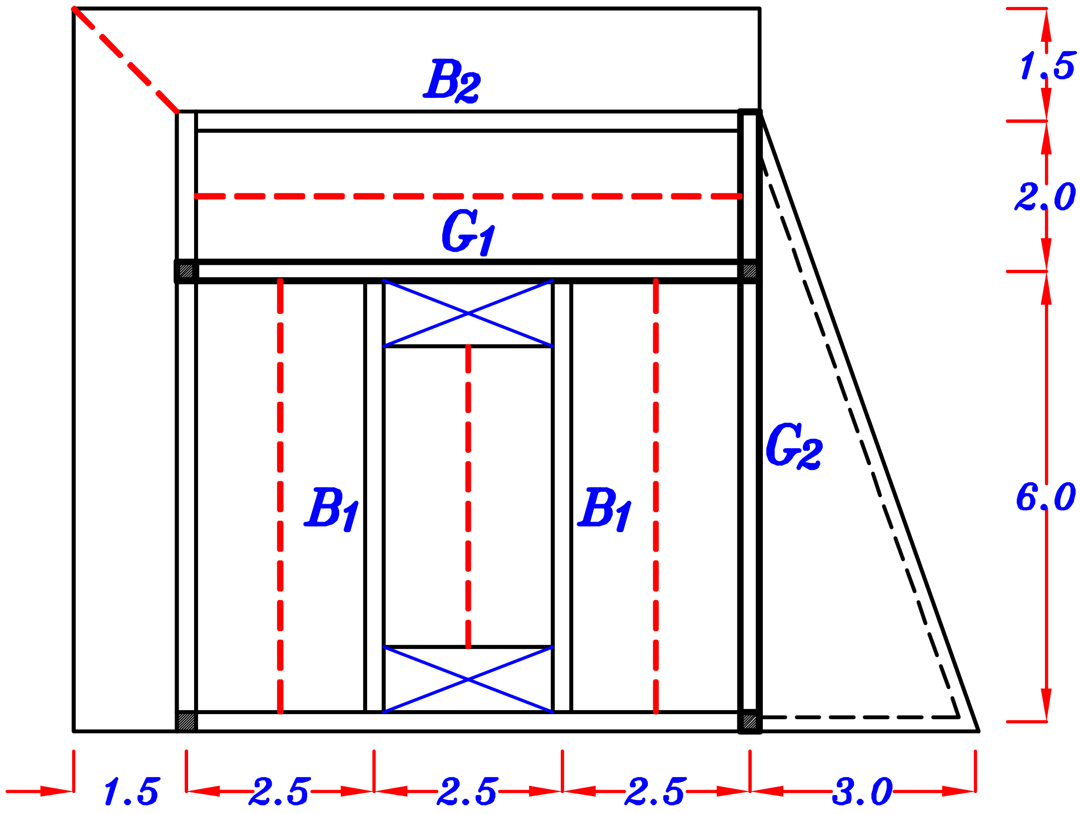
$h\,(1.0 * 1.0)\,\gamma_{soil}$

$$g_{s3} = t_{s3} * \gamma_c + F.C. + Soil$$

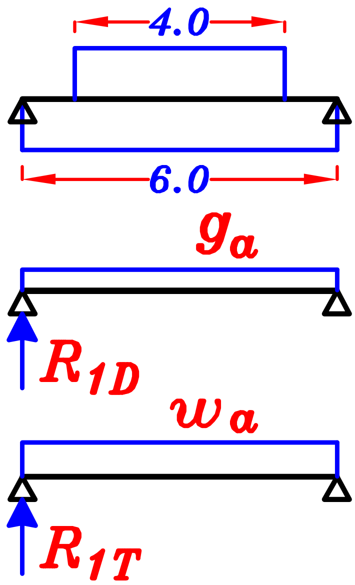
$$= 0.30 * 25 + 1.50 + 0.5 * 20 = 19.0 \ kN\backslash m^2$$

$$p_s = L.L. = 3.0 \ kN\backslash m^2$$





B_1

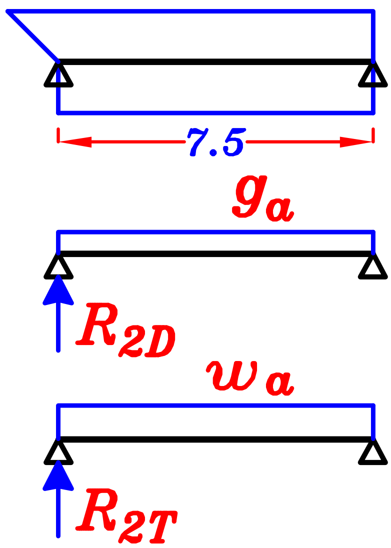


$$g_a = o.w. + g_{s1} * \frac{L_s}{2} + \frac{\sum area}{Span} * g_{s1}$$

$$p_a = p_s * \frac{L_s}{2} + \frac{\sum area}{Span} * p_s$$

$$w_a = g_a + p_a$$

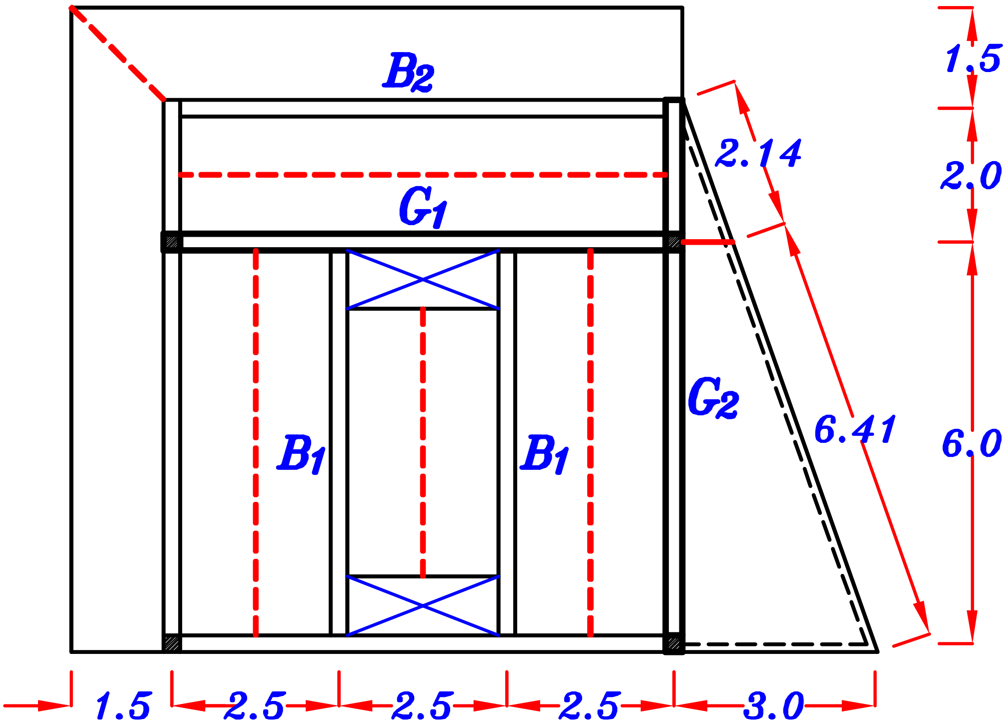
B_2



$$g_a = o.w. + g_{s1} * \frac{L_s}{2} + \frac{\sum area}{Span} * g_{s2}$$

$$p_a = p_s * \frac{L_s}{2} + \frac{\sum area}{Span} * p_s$$

$$w_a = g_a + p_a$$

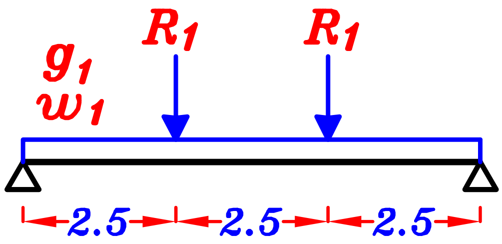


G_1

$$g_1 = o.w. + g_{s1} * \frac{L_s}{2}$$

$$p_1 = p_s * \frac{L_s}{2}$$

$$w_1 = g_1 + p_1$$



G_2

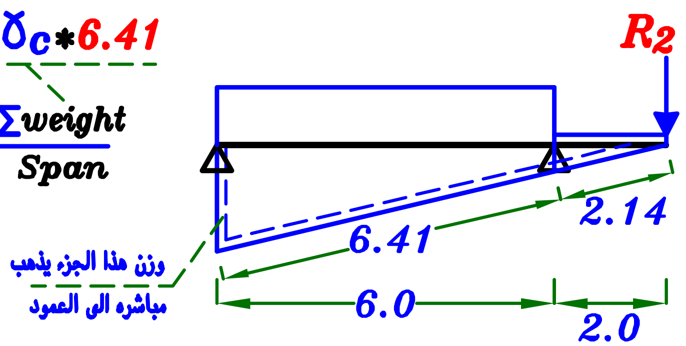
Fence weight

$bh\gamma_c * 6.41$

$$g_1 = o.w. + g_{s1} * \frac{L_s}{2} + \frac{\Sigma\, area}{Span} * g_{s3} + \frac{\Sigma weight}{Span}$$

$$p_1 = p_s * \frac{L_s}{2} + \frac{\Sigma\, area}{Span} * p_s$$

$$w_1 = g_1 + p_1$$

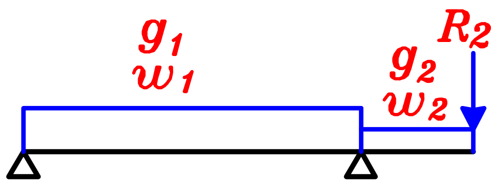


$bh\gamma_c * 2.14$

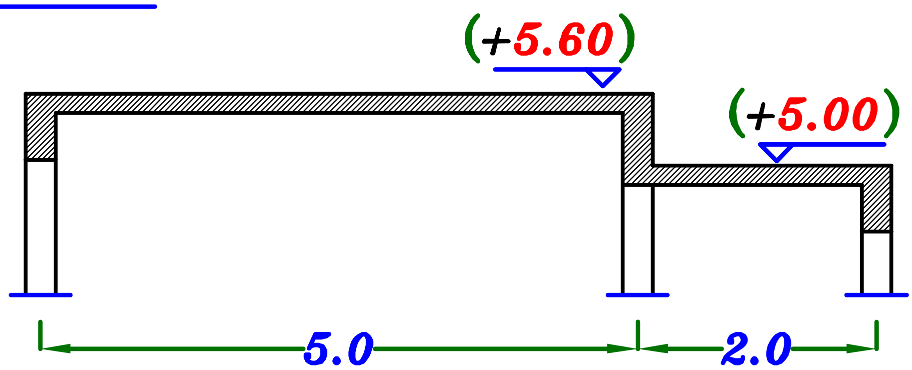
$$g_2 = o.w. + \frac{\Sigma\, area}{Span} * g_{s3} + \frac{\Sigma weight}{Span}$$

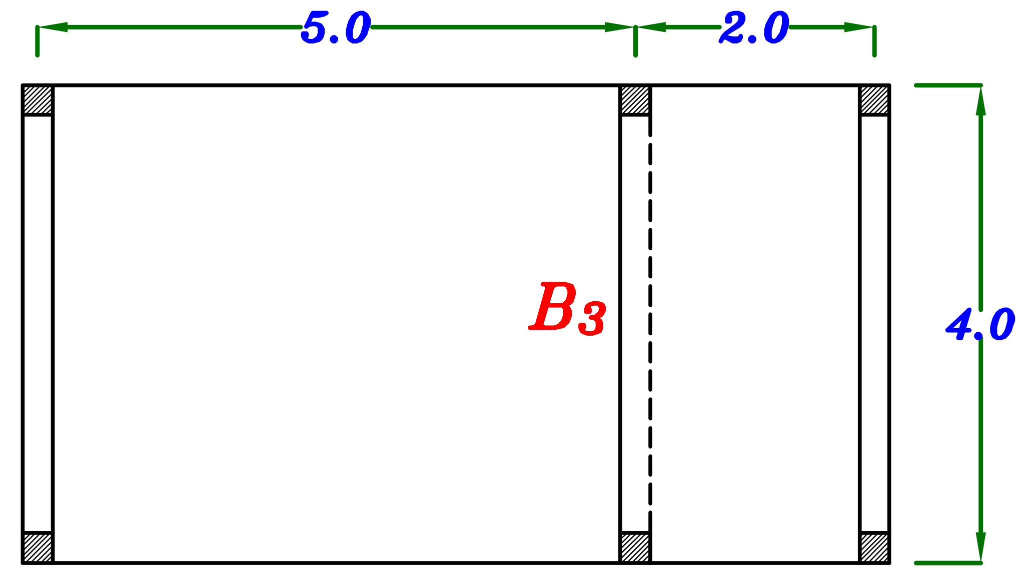
$$p_2 = \frac{\Sigma\, area}{Span} * p_s$$

$$w_2 = g_2 + p_2$$



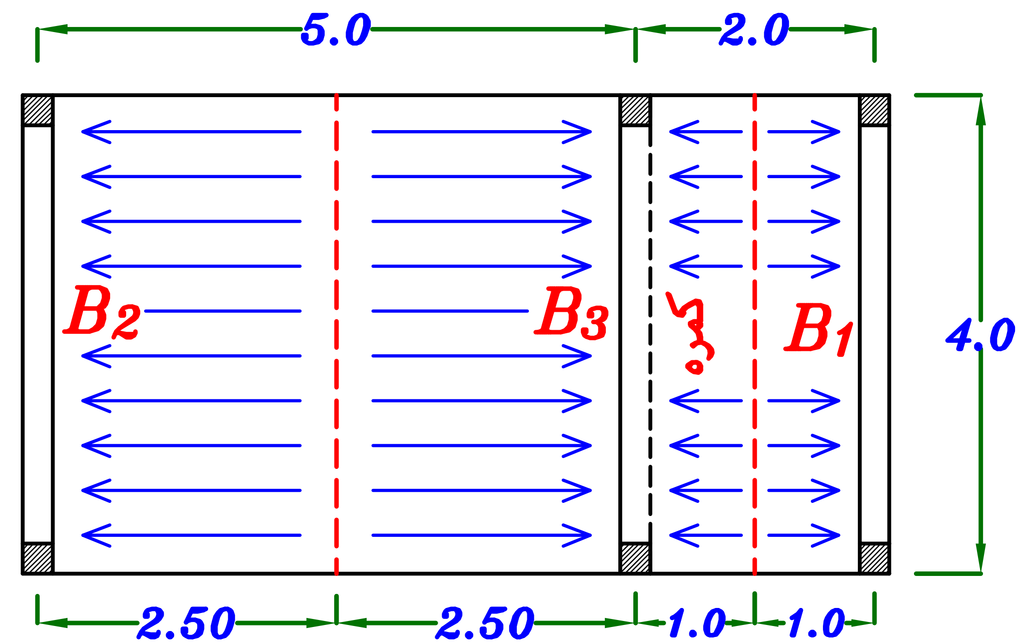
Example.

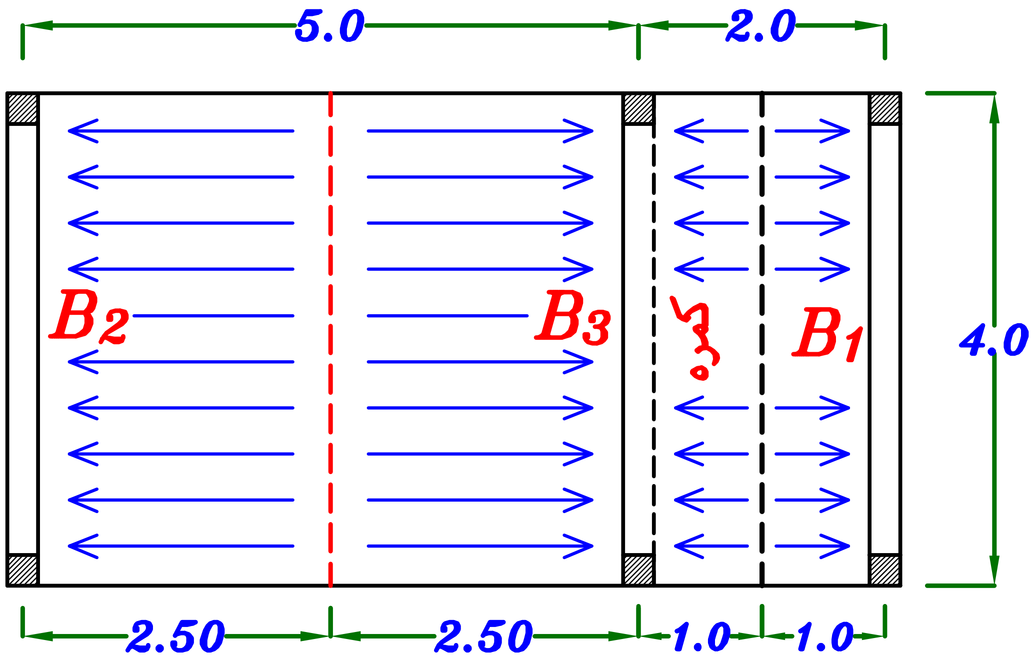




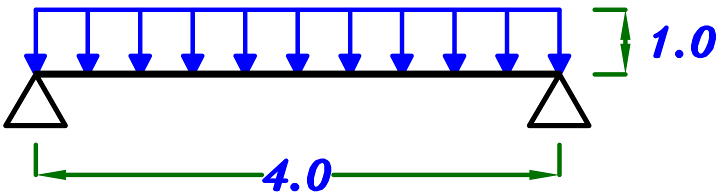
لان B_3 محموله على supports 2 اذا ستكون B_3 كمره تحمل البلاطه

أى ان البلاطه محموله على الكمرات B_2 ، B_3 و الكمرات B_1 ، B_3

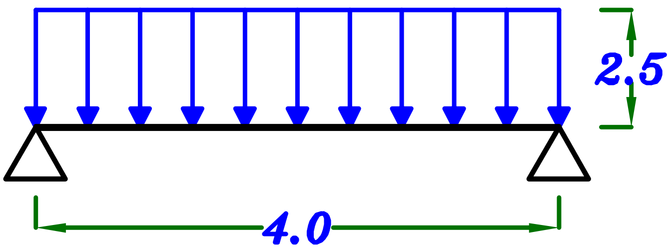




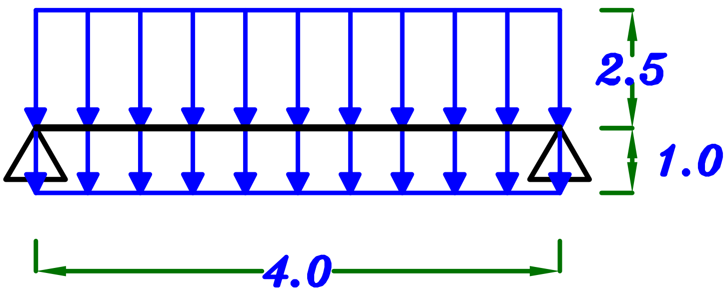
B1



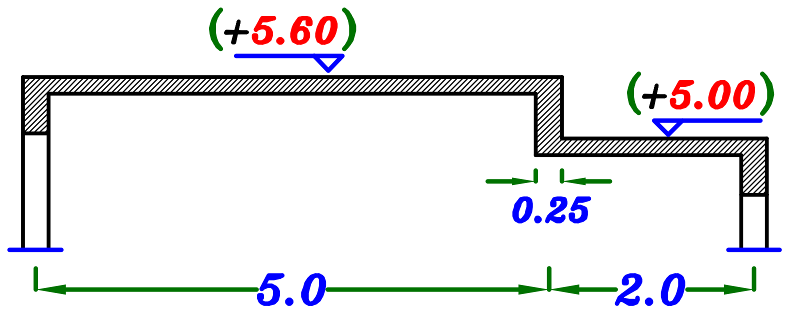
B2

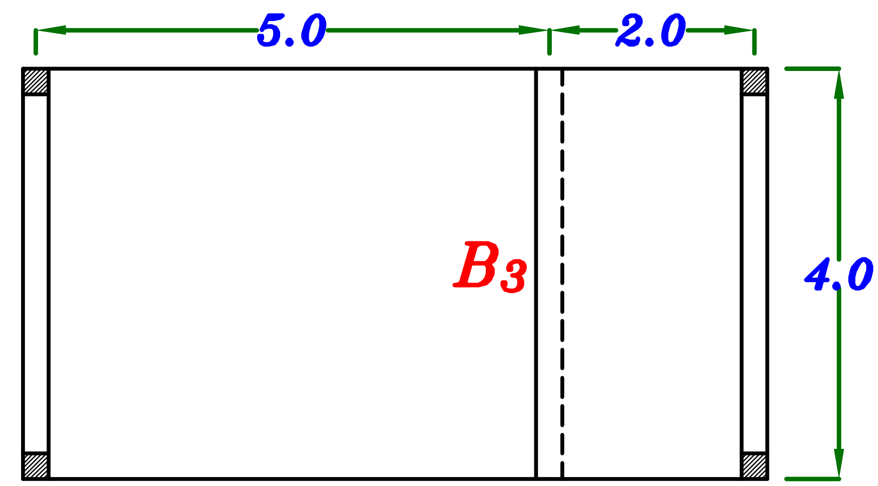


B3

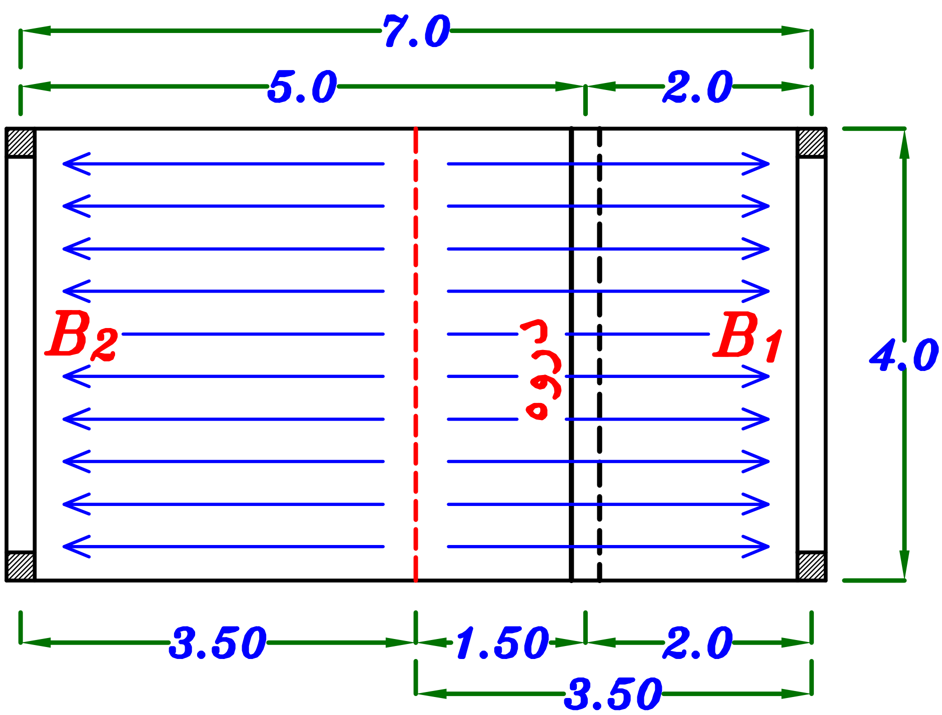


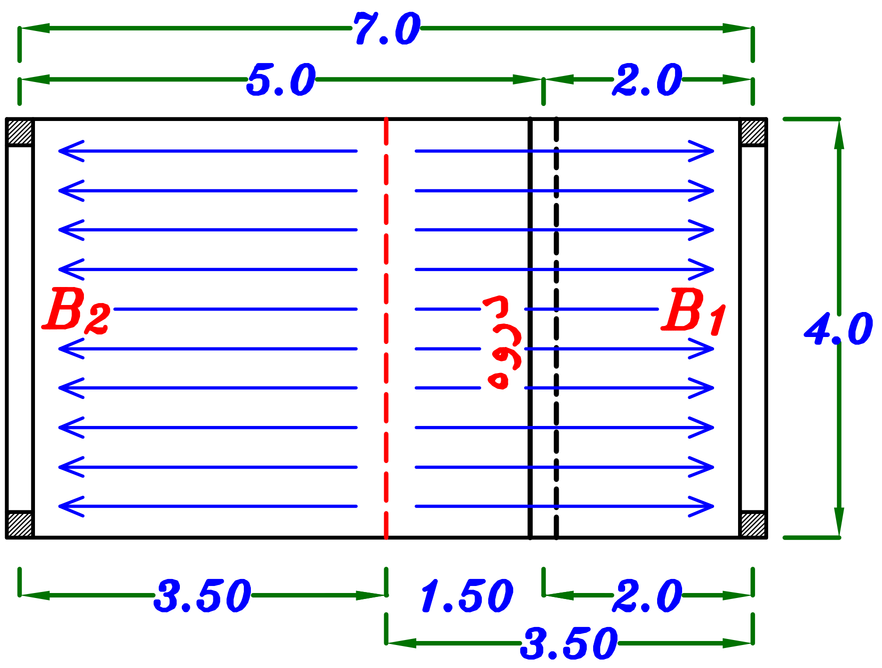
Example.





لان B_3 ليست محموله على **supports 2** اى ستكون محموله فقط على البلاطه
و بالتالى ستكون دروه و ليست كمره .
أى أن البلاطه كلها محموله على كمرتين فقط و هما B_2 و B_1
و يكون وزن الدروه B_3 محمول على الكمره B_1

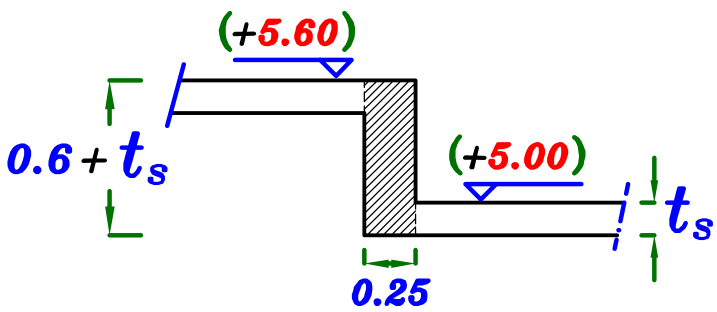




Parapet weight وزن الدروه

$$= 0.25 * (0.6 + t_s) * \gamma_c$$

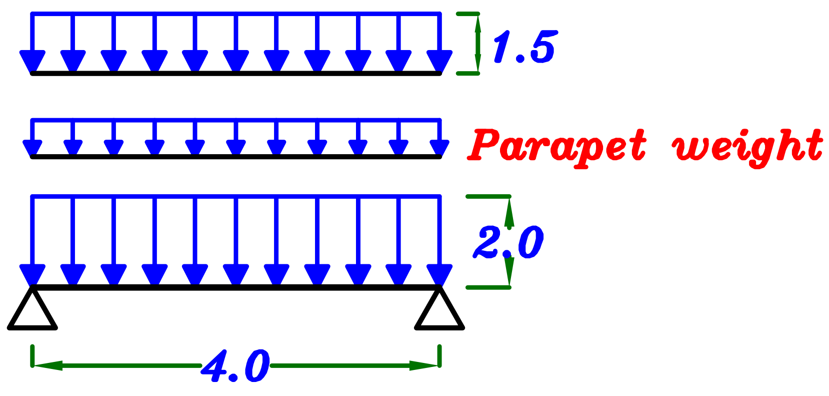
$$= \checkmark \ kN/m$$



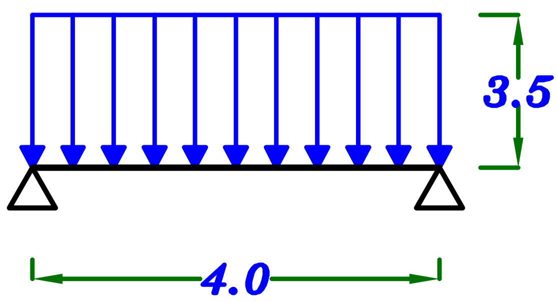
او ممكن للتسهيل اخذ وزنها

$$= 0.25 * 0.6 * \gamma_c$$

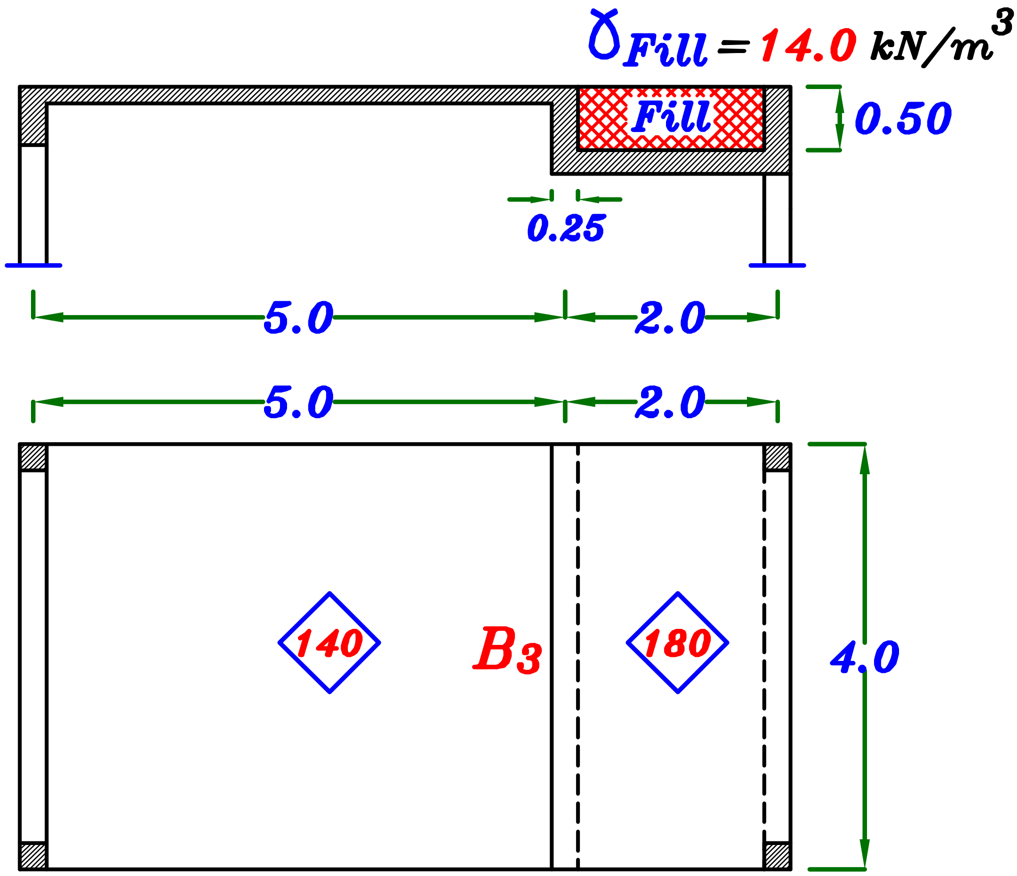
B_1



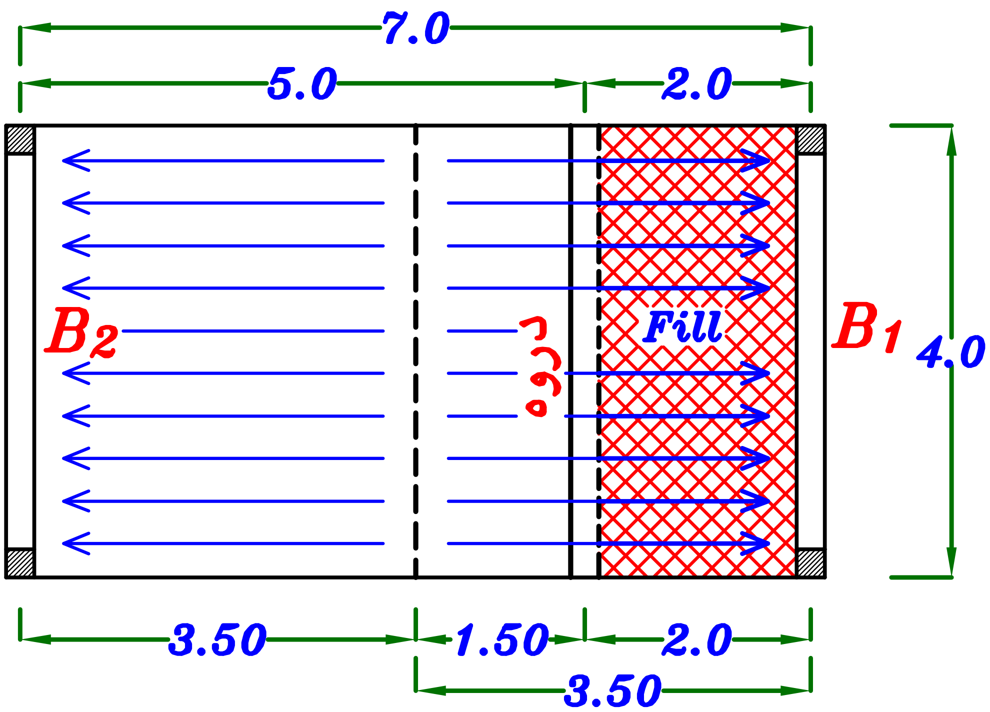
B_2



Example.

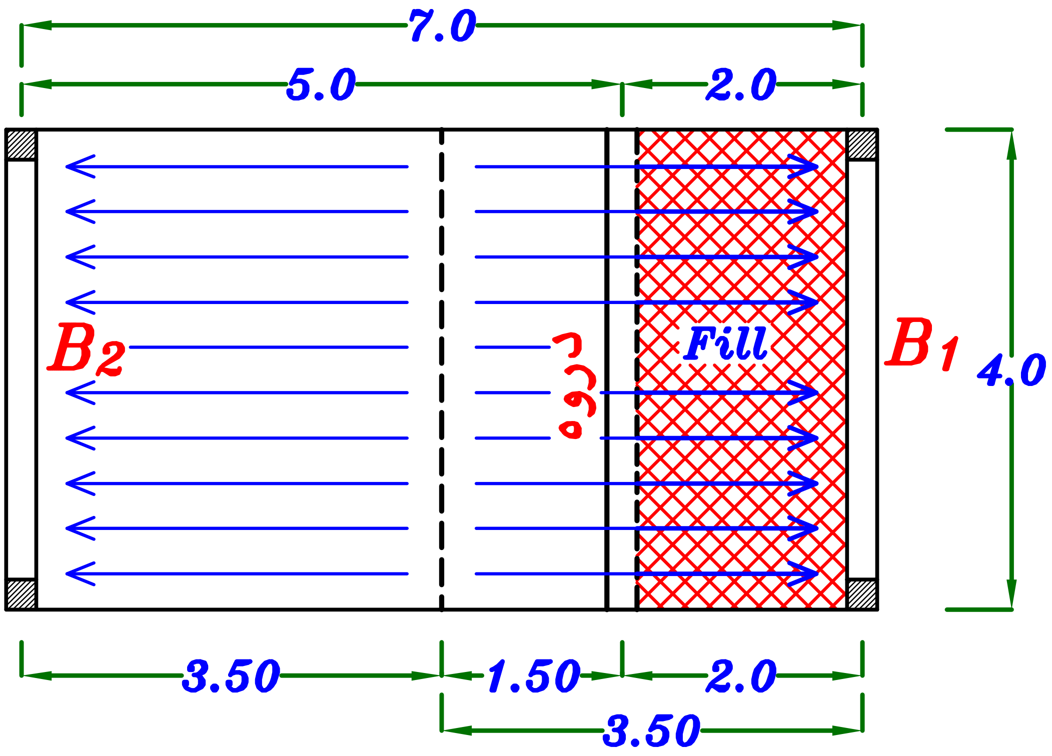


لان B_3 ليست محموله على 2 supports اى ستكون محموله فقط على البلاطه
و بالتالى ستكون دروه و ليست كمره .
أى أن البلاطه كلها محموله على كمرتين فقط و هما B_1 , B_2
و يكون وزن الدروه B_3 محمول على الكمره B_1

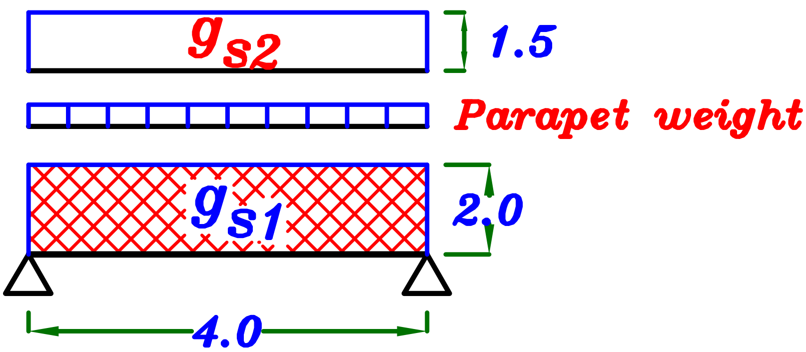


$$g_{s1} = \overset{0.18}{t_{s1}} * \gamma_c + F.C. + \overset{0.5}{h_{Fill}} * \overset{14.0}{\gamma_{Fill}}$$

$$g_{s2} = \overset{0.14}{t_{s1}} * \gamma_c + F.C.$$

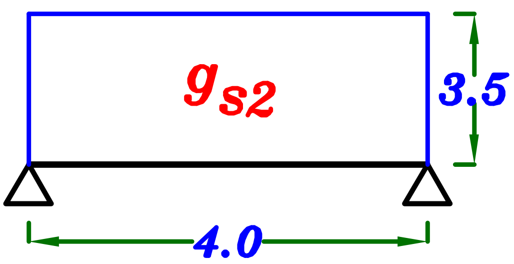


B_1



$$w = o.w + g_{s1} * 2.0 + \text{Parapet weight} + g_{s2} * 1.5$$

B_2



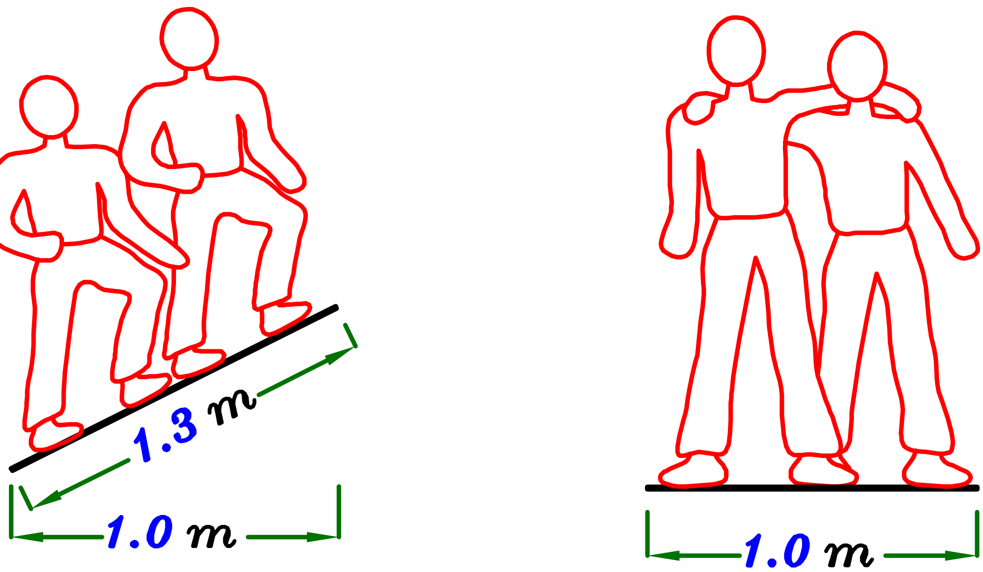
$$w = o.w + g_{s2} * 3.5$$

Inclined Slabs. البلاطات المائله

هناك نقطتان أساسيتان يجب أن تؤخذا فى الإعتبار مع البلاطات المائله :

١ـ جميع الأحمال تؤخذ على الطول المائل.

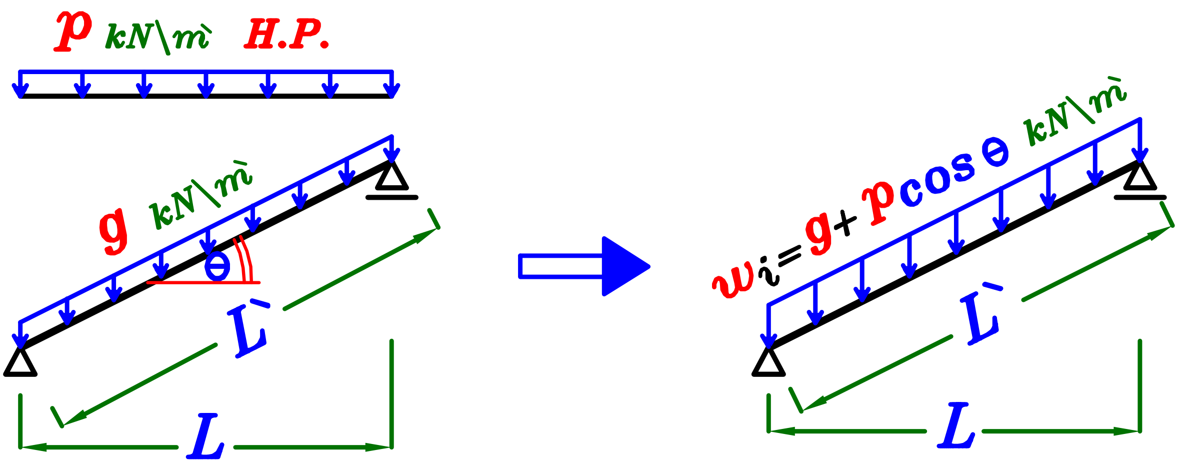
ماعدا الحمل الحى *L.L.* يؤخذ على الطول الأفقى .



***H.P.* Horizontal Projection المسقط الأفقى**

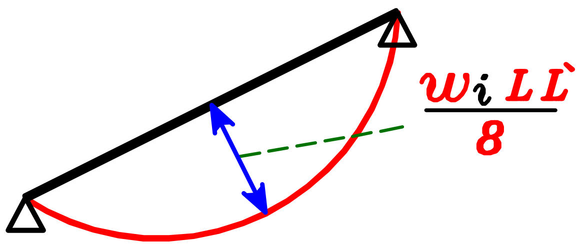
عدد الأشخاص الذين يستطيعوا أن يقفوا على ١,٠ م أفقى فقط

هو نفس عدد الأشخاص الذين يستطيعوا أن يقفوا على ١,٣٠ م مائل.



$$\boxed{w_i = g + p * \cos\theta}$$

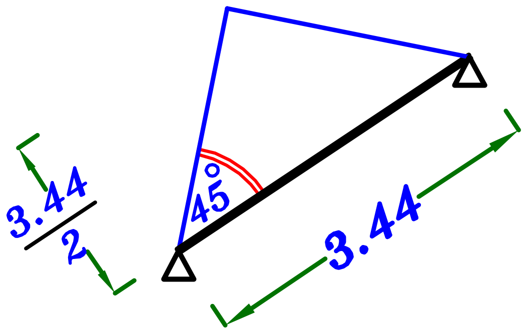
B.M.D.

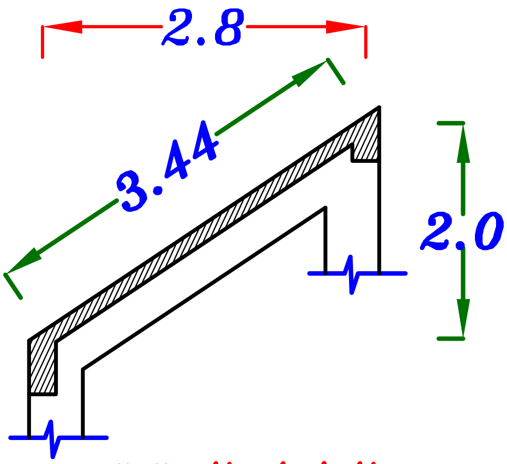


٢- عند توزيع الاحمال فى البلاطات المائله يجب ان نأخذ الاطوال الحقيقيه و ليس المساقط.

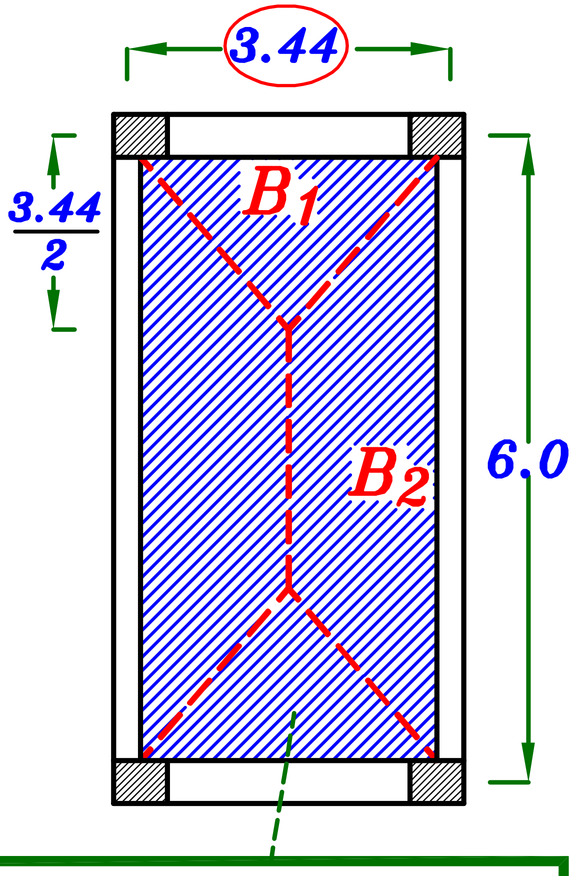
Example.

B_1





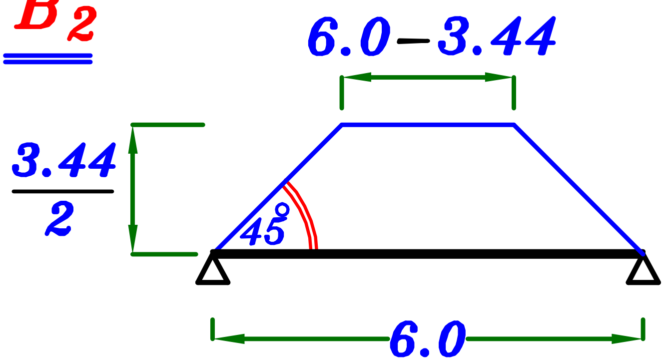
الطول الحقيقى



$$w_{si} = t_s \gamma_c + F.C. + L.L. \cos\theta = \checkmark \ kN\backslash m^2$$

$$w = O.W. + walls + C_a \, w_{si} \left(\frac{3.44}{2}\right) = \checkmark \ kN\backslash m'$$

B_2



$$C_a = 1 - \frac{1}{2}\left(\frac{3.44}{6.0}\right)$$

$$C_e = 1 - \frac{1}{3}\left(\frac{3.44}{6.0}\right)^2$$

يفضل فى ال **plan** تهشير البلاطات المائله حتى تتذكر انها مائله و ليست افقيه .

$$w_{si} = t_s \gamma_c + F.C. + L.L. \cos\theta = \checkmark \ kN\backslash m^2$$

$$w = O.W. + walls + C_a \, w_{si} \left(\frac{3.44}{2}\right) = \checkmark \ kN\backslash m'$$

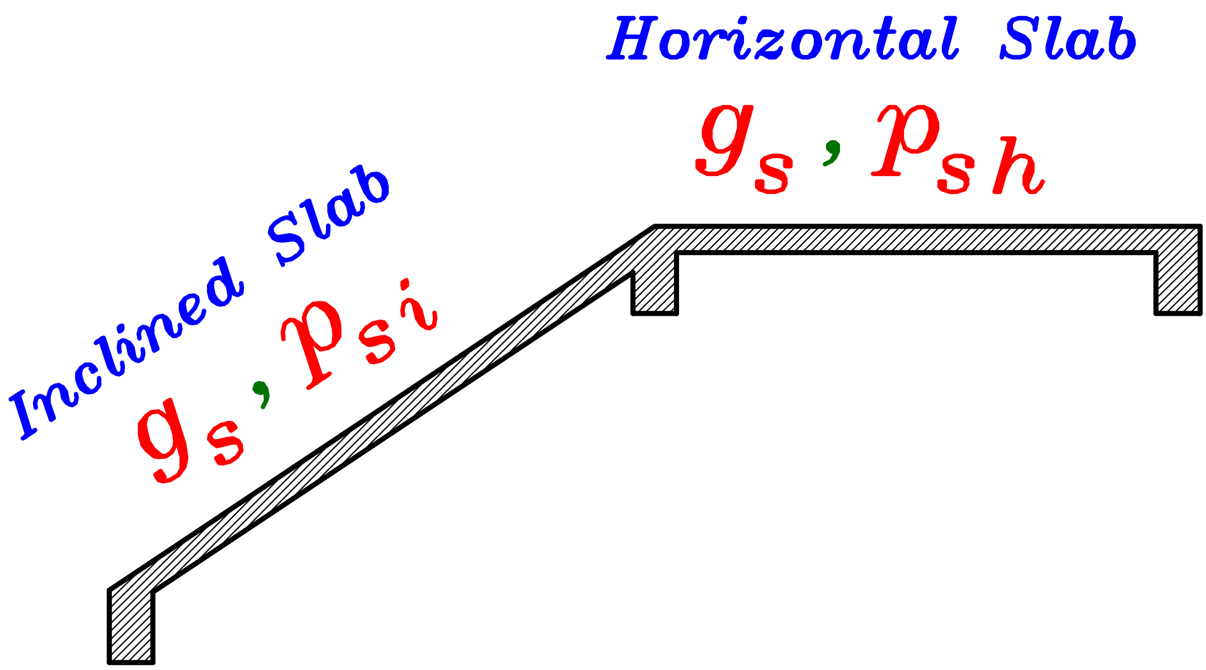
Max–Max B.M.D.
For Inclined Slabs

Load of the Slab.

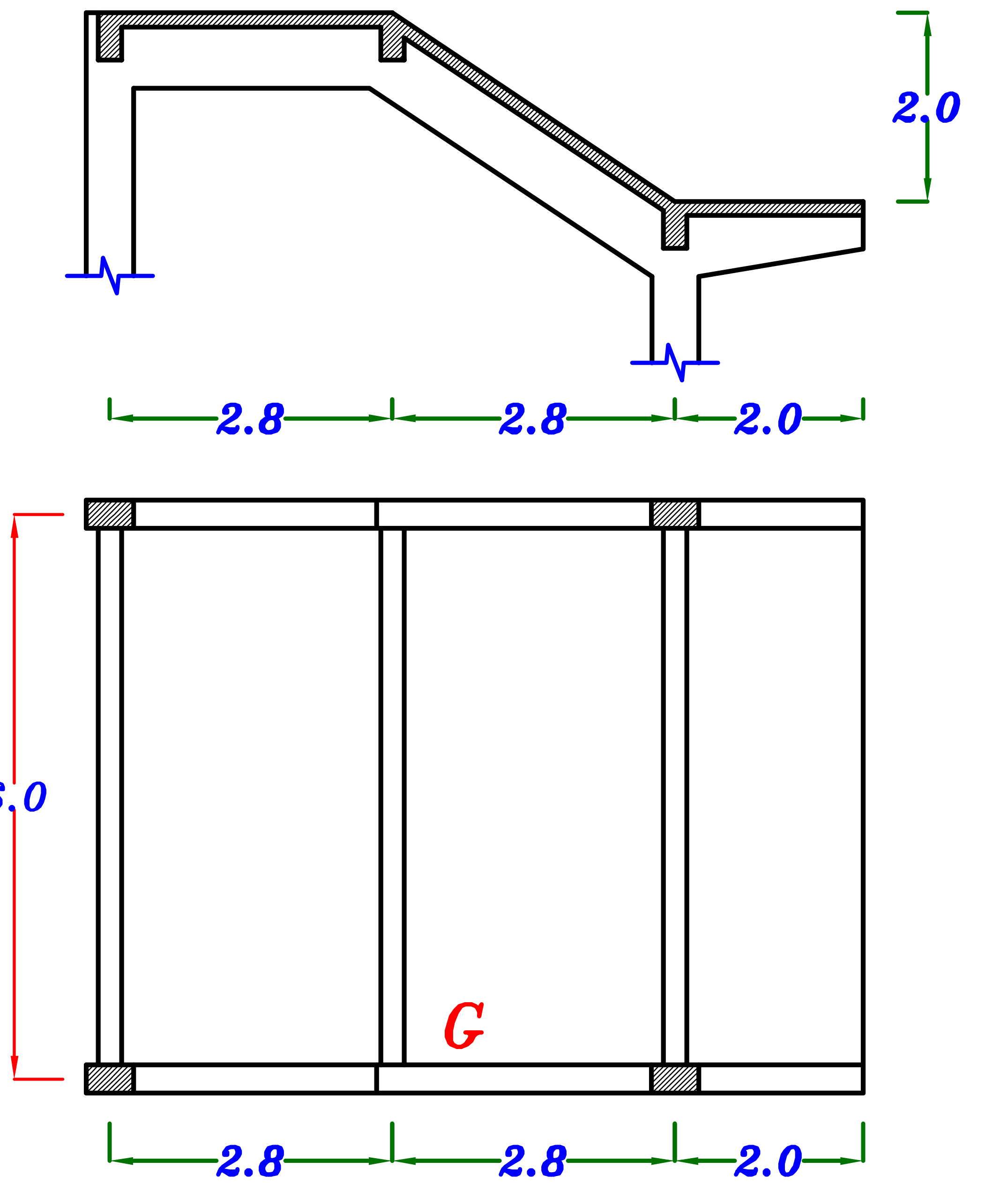
$$\boxed{g_s = t_s * \gamma_c + F.C.}$$ For Horizontal & Inclined Slabs

$$\boxed{p_{sh} = L.L.}$$ For Horizontal Slabs

$$\boxed{p_{si} = L.L.\ \cos\theta}$$ For Inclined Slabs



Example.



Data.

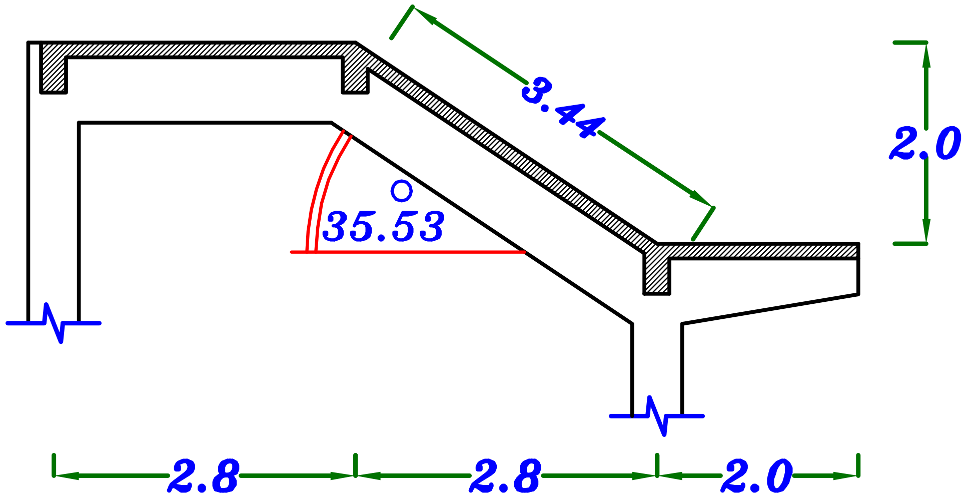
$t_s = 0.12\ m$, F.C. $= 1.50\ kN\backslash m^2$, L.L. $= 2.0\ kN\backslash m^2$

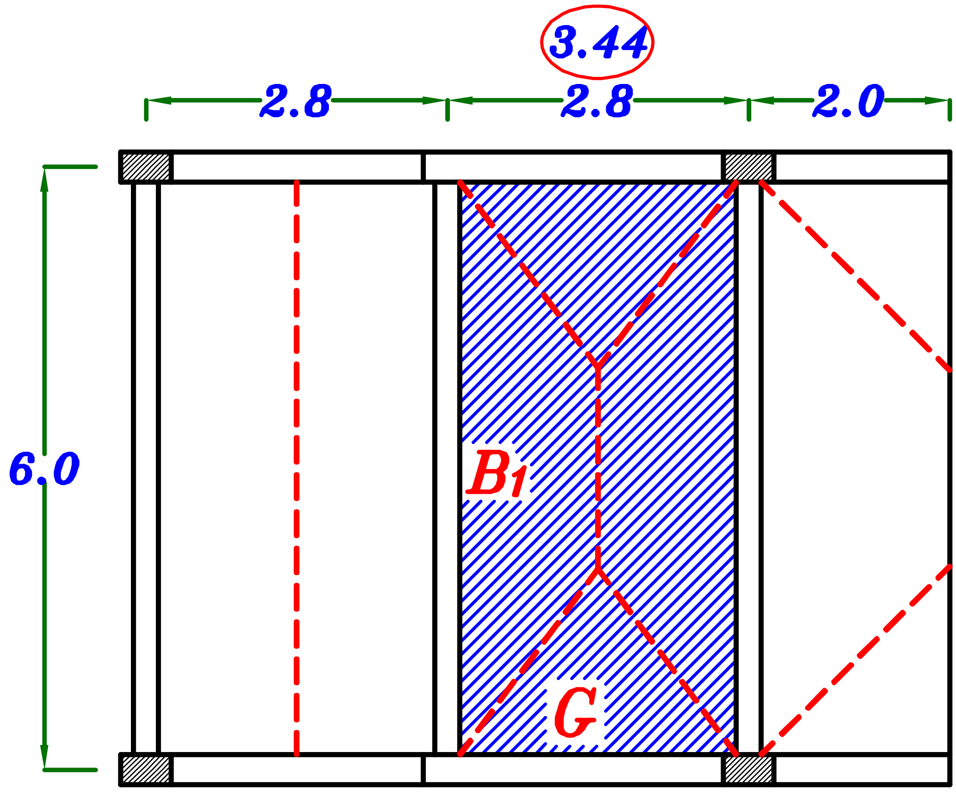
O.W. of Beam $= 3.0\ kN\backslash m'$, O.W. of Girder $= 5.0\ kN\backslash m'$

Req.

1- Draw max.-max. B.M.D. For the Girder.

2- Draw S.F.D. & N.F.D. Case of total load only.





g_s , p_s

$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.50 \; kN\backslash m^2$

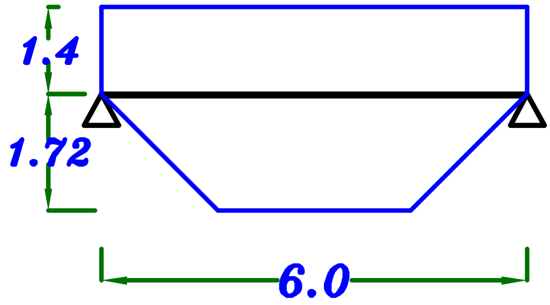
$p_{sh} = L.L. = 2.0 \; kN\backslash m^2$ ------ HL. Slab.

$p_{si} = L.L. * \cos\theta = 2.0 * \cos 35.53^\circ = 1.63 \; kN\backslash m^2$ --- Inclined Slab.

$\boxed{g_s = 4.50 \; kN\backslash m^2}$, $\boxed{p_{sh} = 2.0 \; kN\backslash m^2}$, $\boxed{p_{si} = 1.63 \; kN\backslash m^2}$

B_1

For Trapezoid



$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.44}{6.0}\right) = 0.713$$

$$g_a = O.W. + g_s \frac{L_s}{2} + C_a\, g_s \frac{L_s}{2}$$

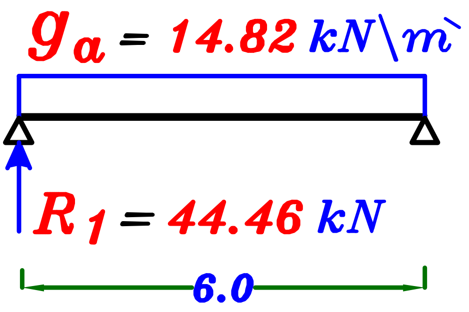
$$= 3.0 + (4.50)\left(\frac{2.8}{2}\right) + (0.713)(4.50)\left(\frac{3.44}{2}\right) = 14.82 \text{ kN}\backslash m'$$

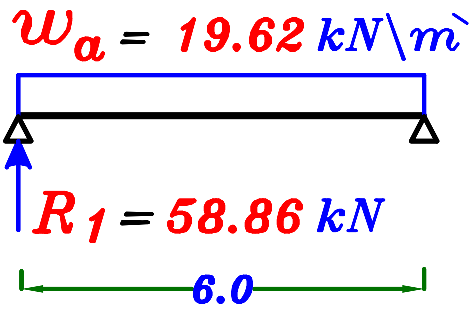
$$p_a = p_{sh} \frac{L_s}{2} + C_a\, p_{si} \frac{L_s}{2}$$

$$= (2.0)\left(\frac{2.8}{2}\right) + (0.713)(1.63)\left(\frac{3.44}{2}\right) = 4.80 \text{ kN}\backslash m'$$

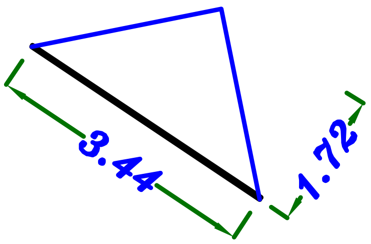
$$w_a = g_a + p_a = 14.82 + 4.80 = 19.62 \text{ kN}\backslash m'$$

$$\boxed{\begin{aligned} R_1 &= 44.46 \text{ kN} \text{ --- D.L.} \\ &= 58.86 \text{ kN} \text{ --- T.L.} \end{aligned}}$$

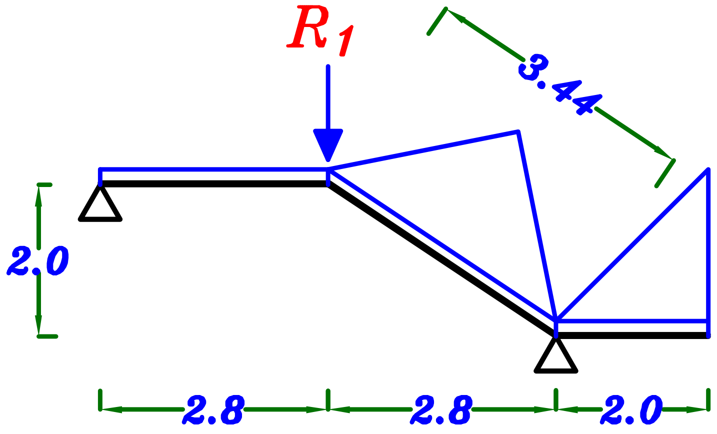


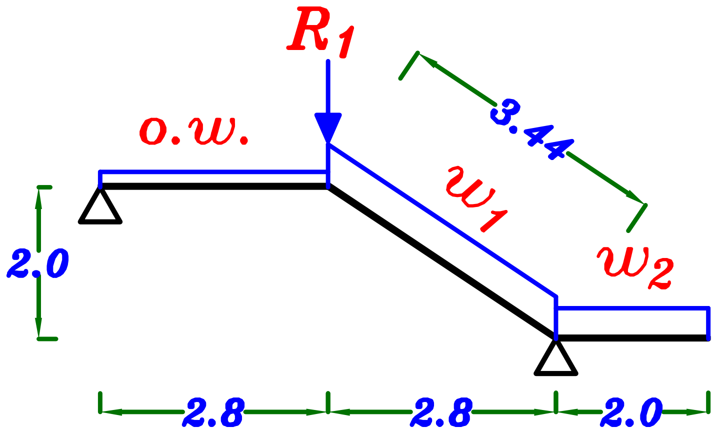


$\underline{\underline{G}}$



$area = 2.96\ m^2$





For Triangle

$$C_a = \frac{1}{2} \quad , \quad C_e = \frac{2}{3}$$

$\underline{\underline{w_1}}$

Load For Shear = Load For Moment

$$g_1 = O.W. + \frac{\sum area}{span} * g_s = 5.0 + \left(\frac{2.96}{3.44}\right)(4.50) = 8.87\ kN\backslash m'$$

$$p_1 = \frac{\sum area}{span} * p_{si} = \left(\frac{2.96}{3.44}\right)(1.66) = 1.42\ kN\backslash m'$$

$$w_1 = g_1 + p_1 = 8.87 + 1.42 = 10.29\ kN\backslash m'$$

$\underline{\underline{w_2}}$

Load For shear.

$$g_a = O.W. + C_a\ g_s\ L_c = 5.0 + \frac{1}{2}(4.50)(2.0) = 9.50\ kN\backslash m$$

$$p_a = C_a\ p_{sh}\ L_c = \frac{1}{2}(2.0)(2.0) = 2.0\ kN\backslash m$$

$$w_a = g_a + p_a = 9.50 + 2.0 = 11.50\ kN\backslash m'$$

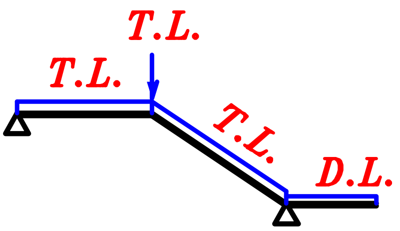
Load For Moment.

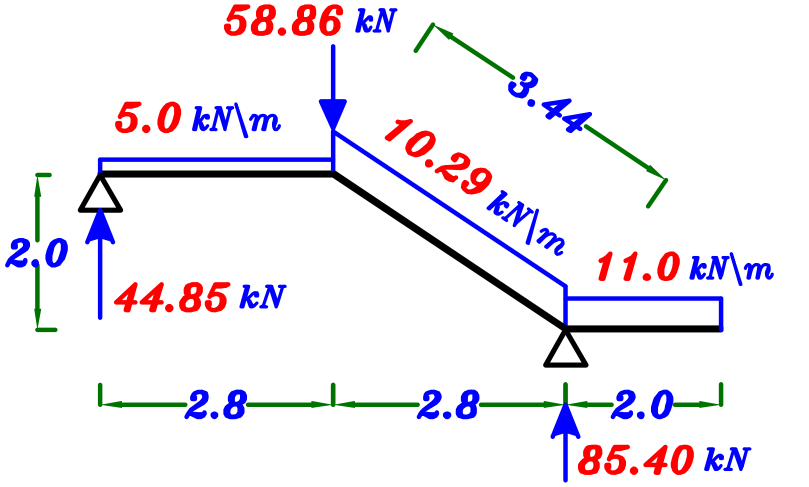
$$g_e = O.W. + C_e\ g_s\ L_c = 5.0 + \frac{2}{3}(4.50)(2.0) = 11.0\ kN\backslash m$$

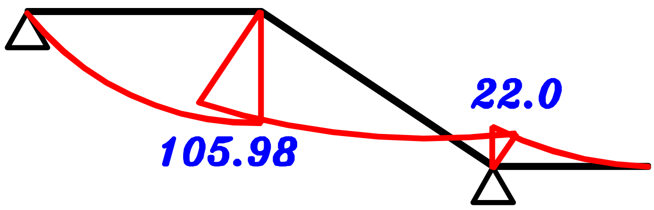
$$p_e = C_e\ p_{sh}\ L_c = \frac{2}{3}(2.0)(2.0) = 2.67\ kN\backslash m$$

$$w_e = g_e + p_e = 11.0 + 2.67 = 13.67\ kN\backslash m'$$

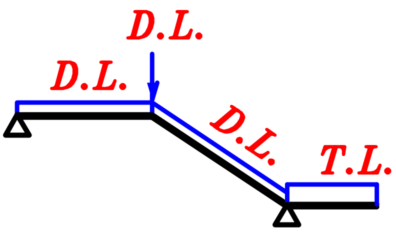
1- max. +Ve B.M.D.

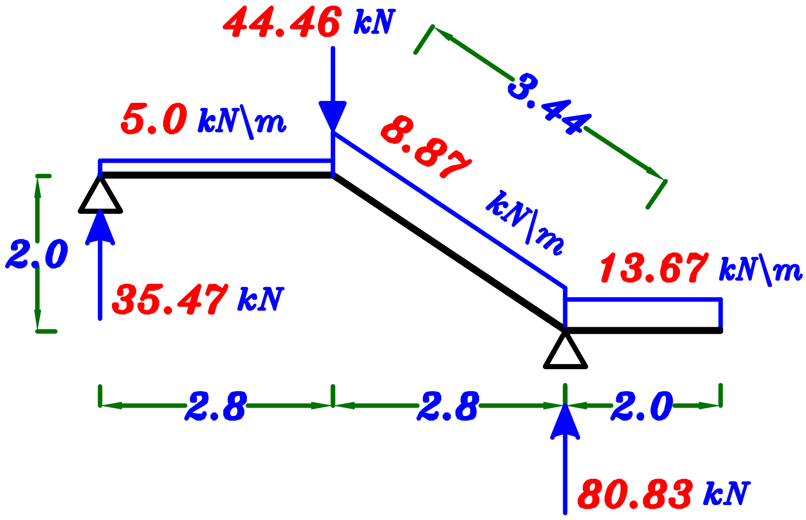


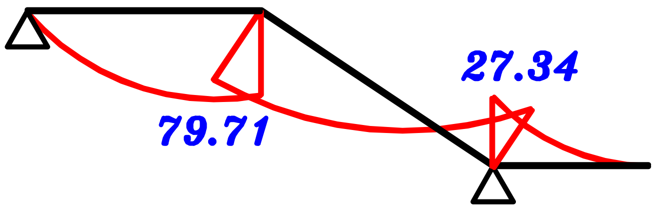




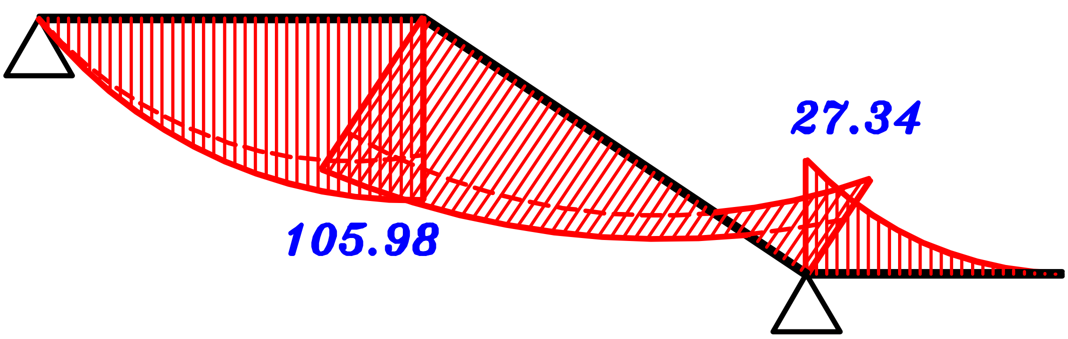
2- max. −Ve B.M.D.



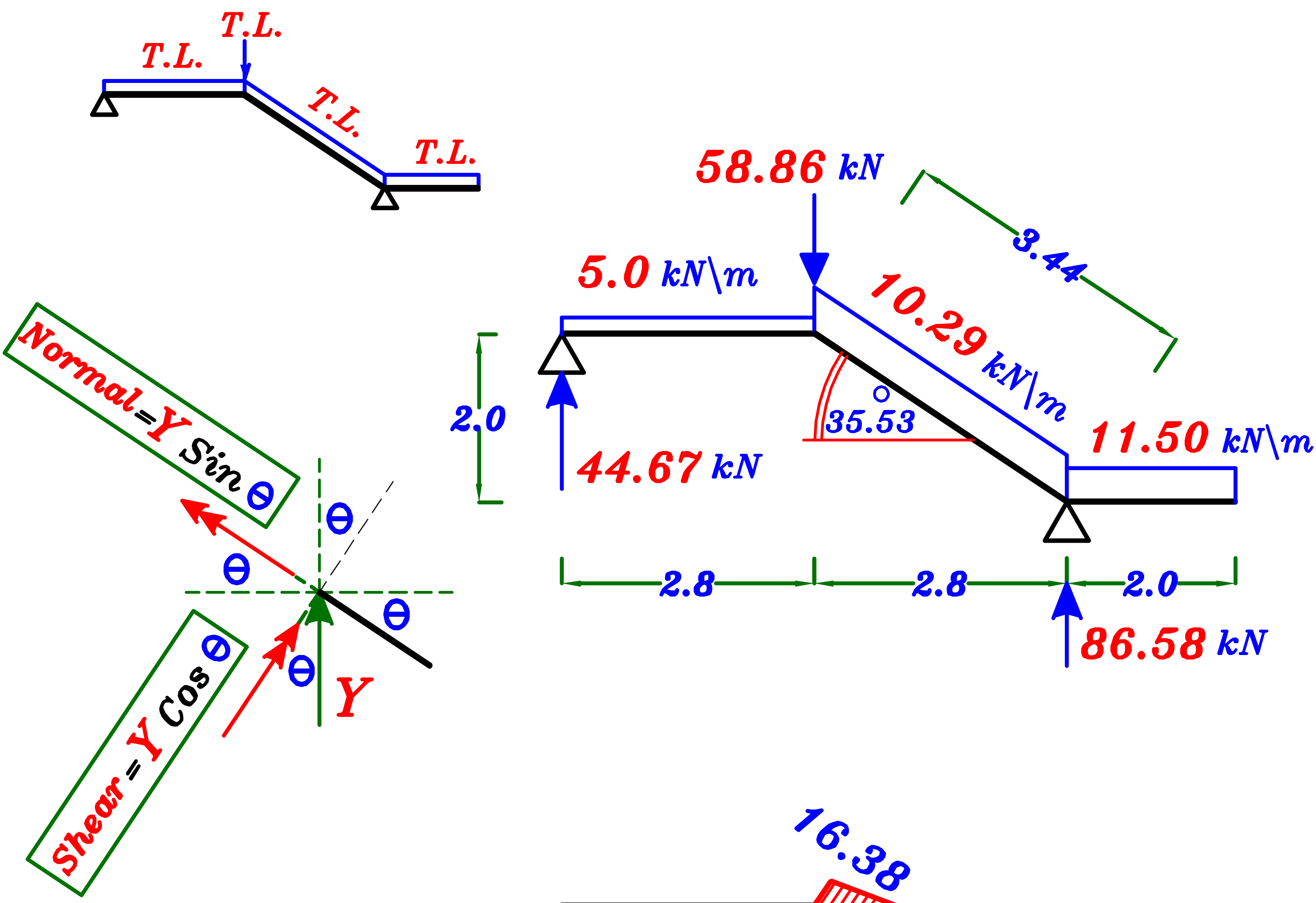




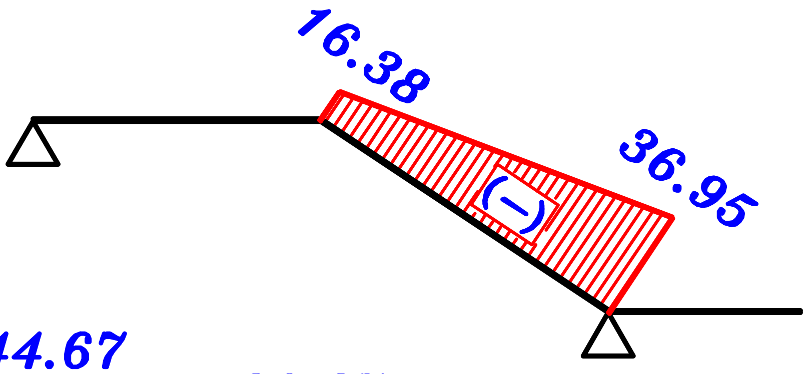
max−max B.M.D. For the Girder.



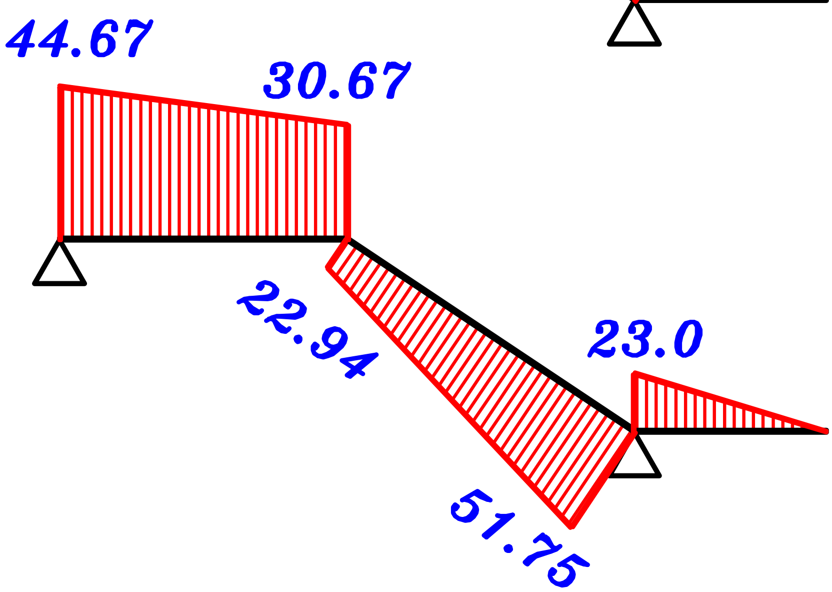
N.F.D. & S.F.D. For the Girder (G)



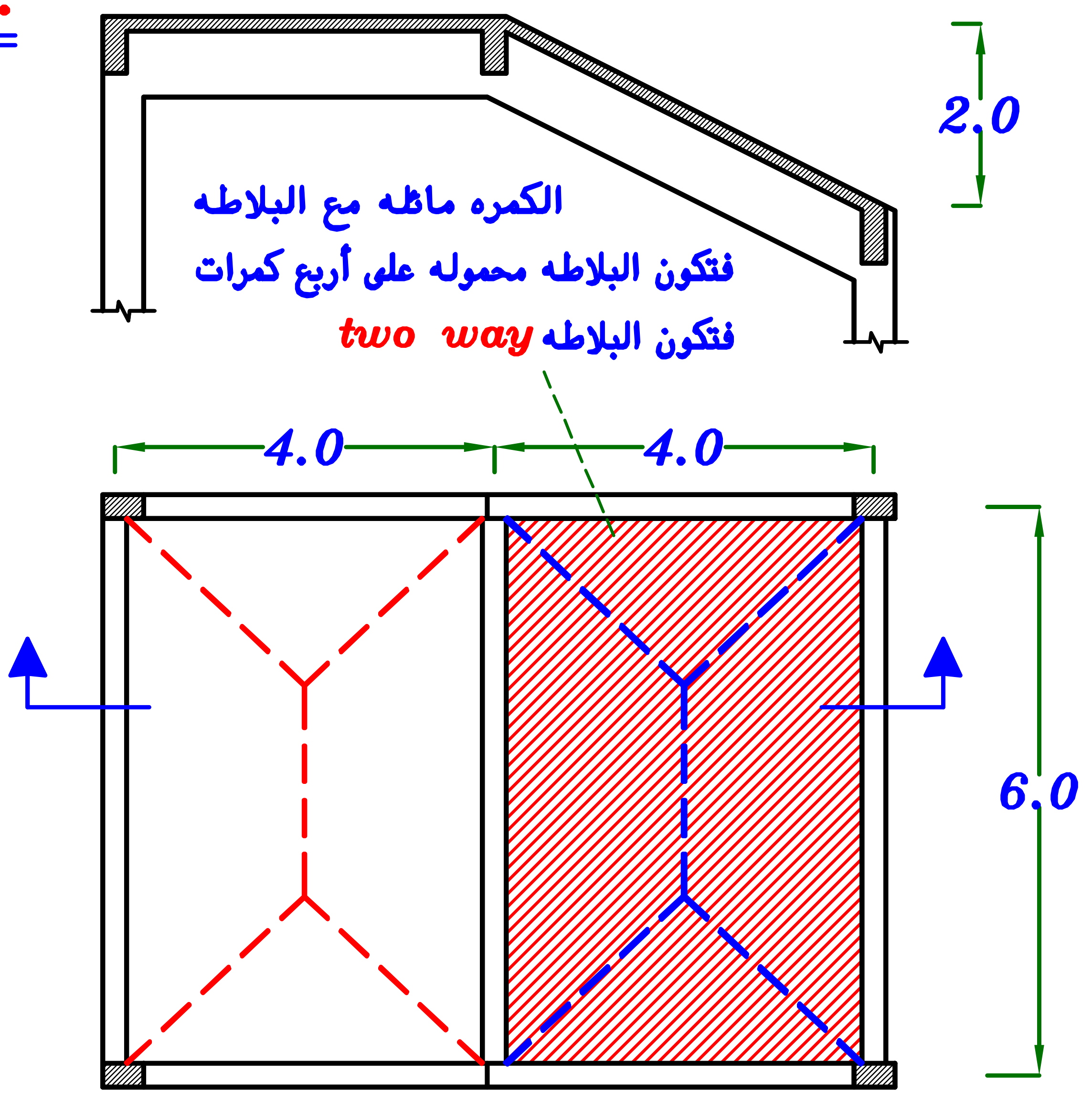
N.F.D.



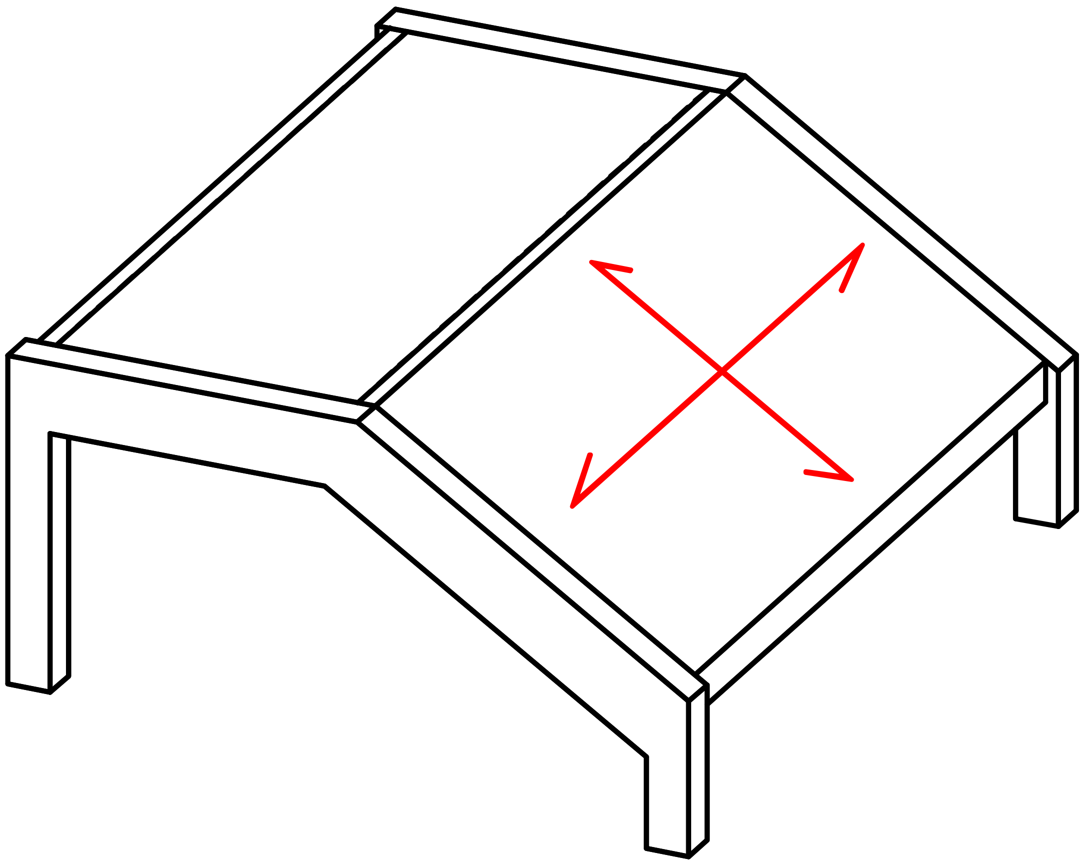
S.F.D.



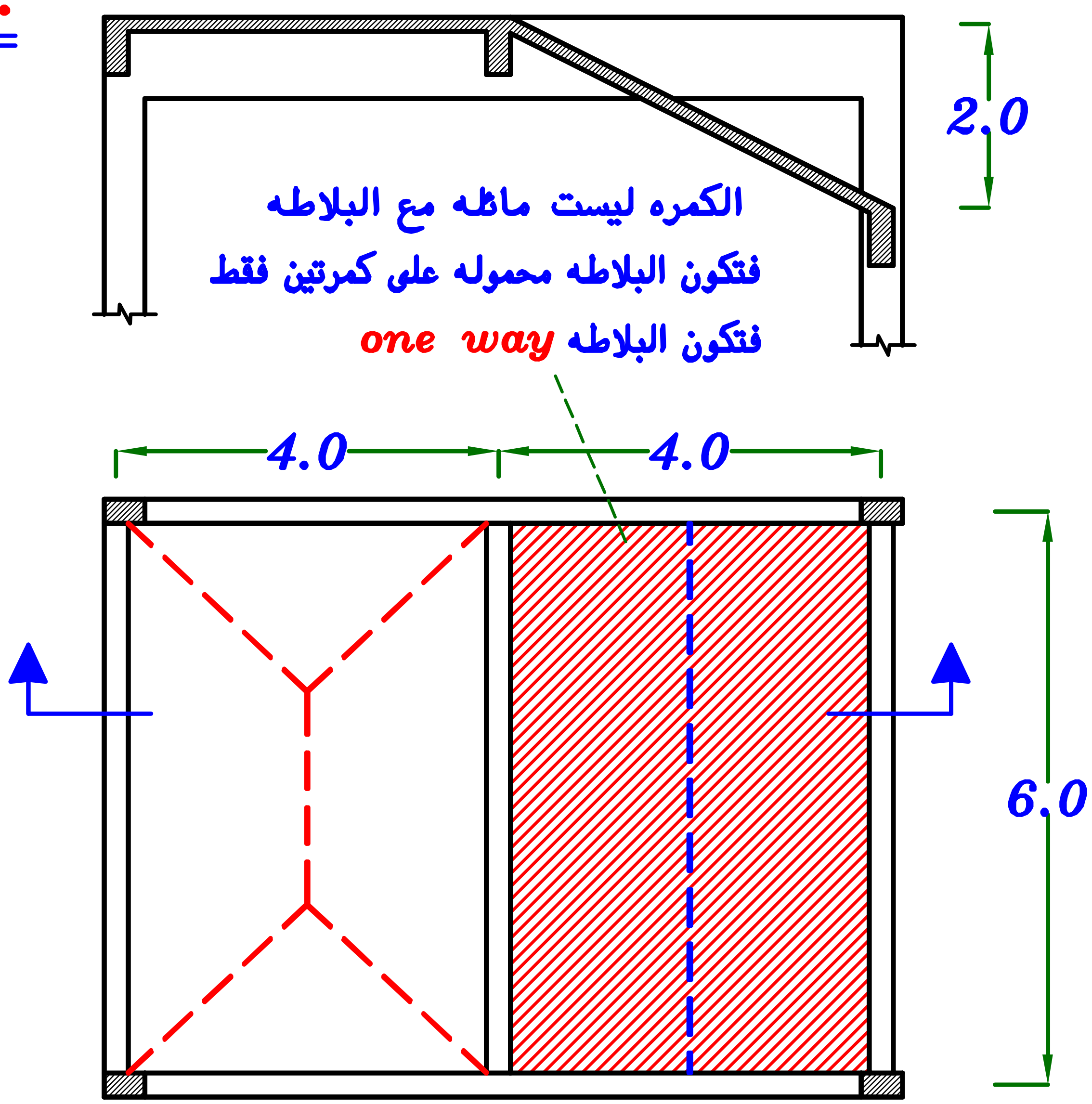
Note.



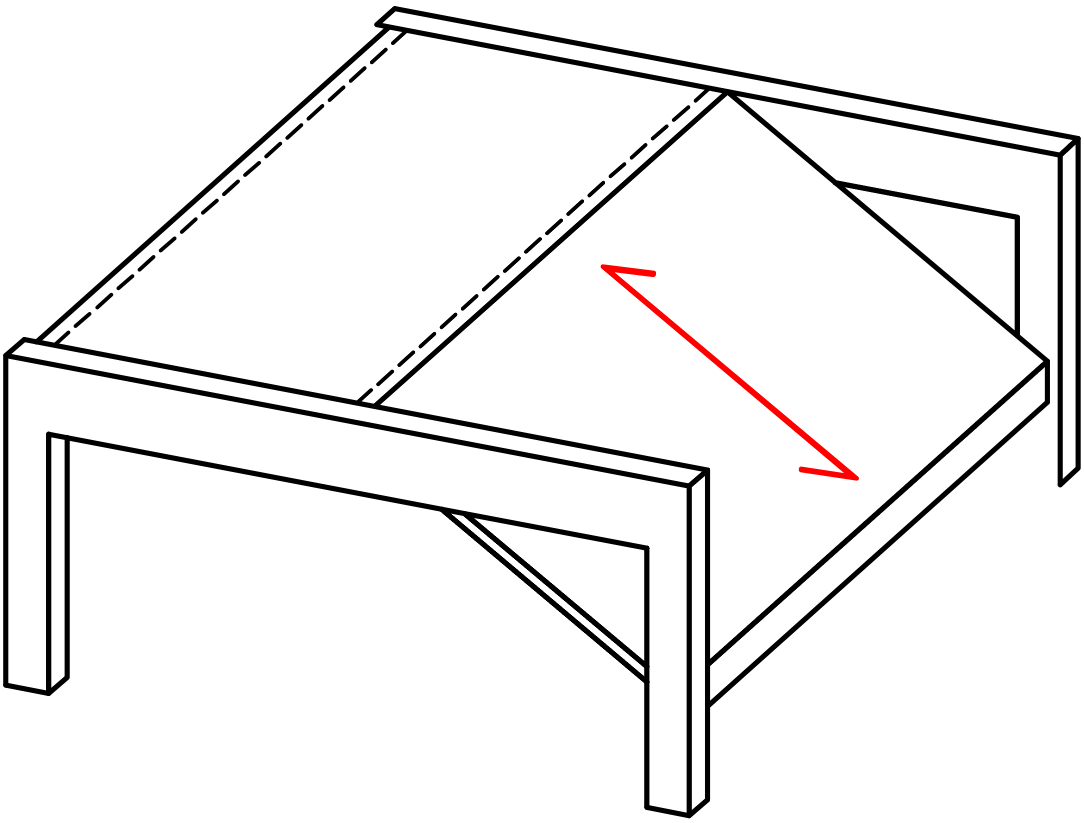
2.0
الكمره مائله مع البلاطه
فتكون البلاطه محموله على أربع كمرات
فتكون البلاطه two way
4.0
4.0
6.0



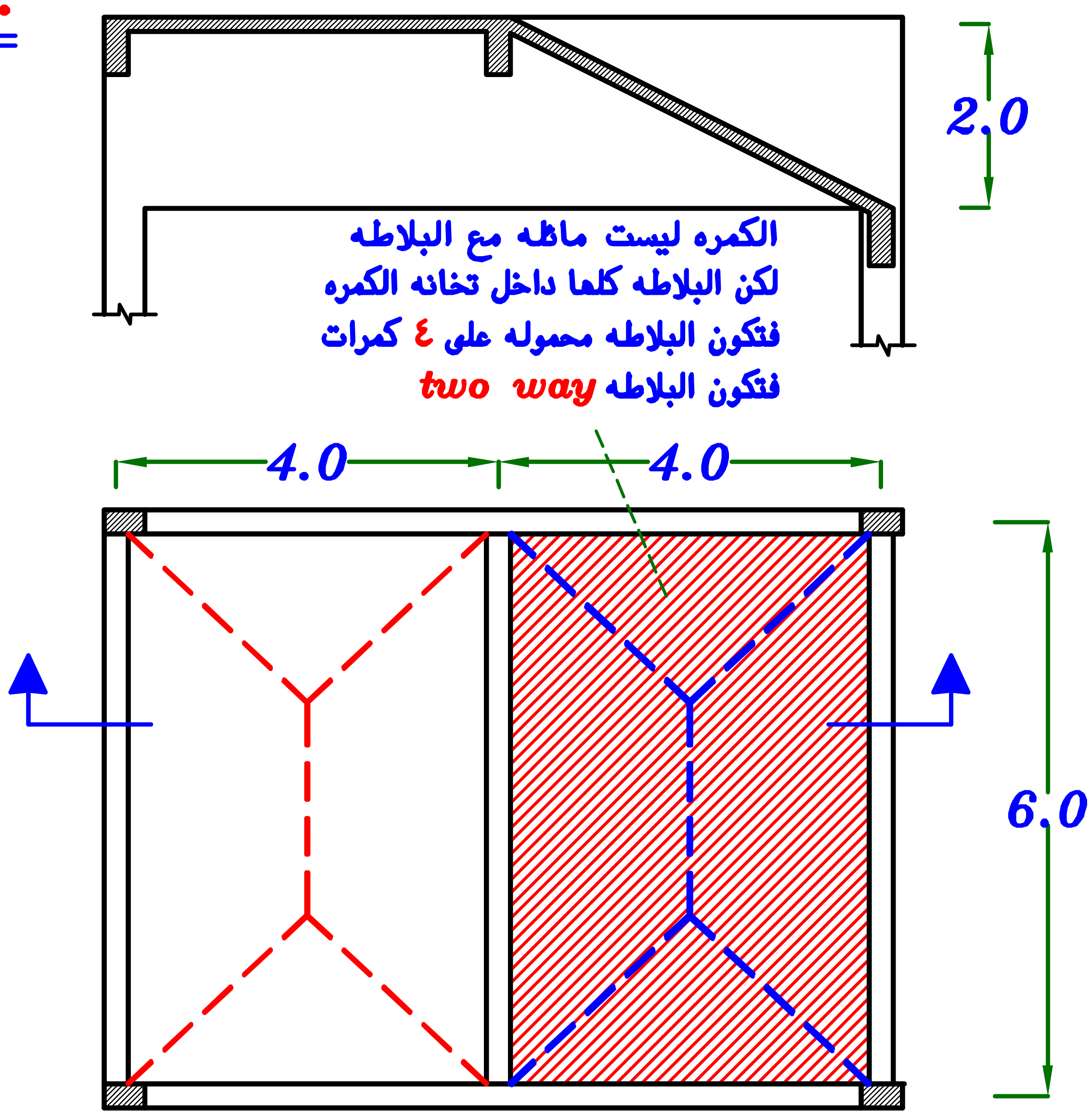
Note.



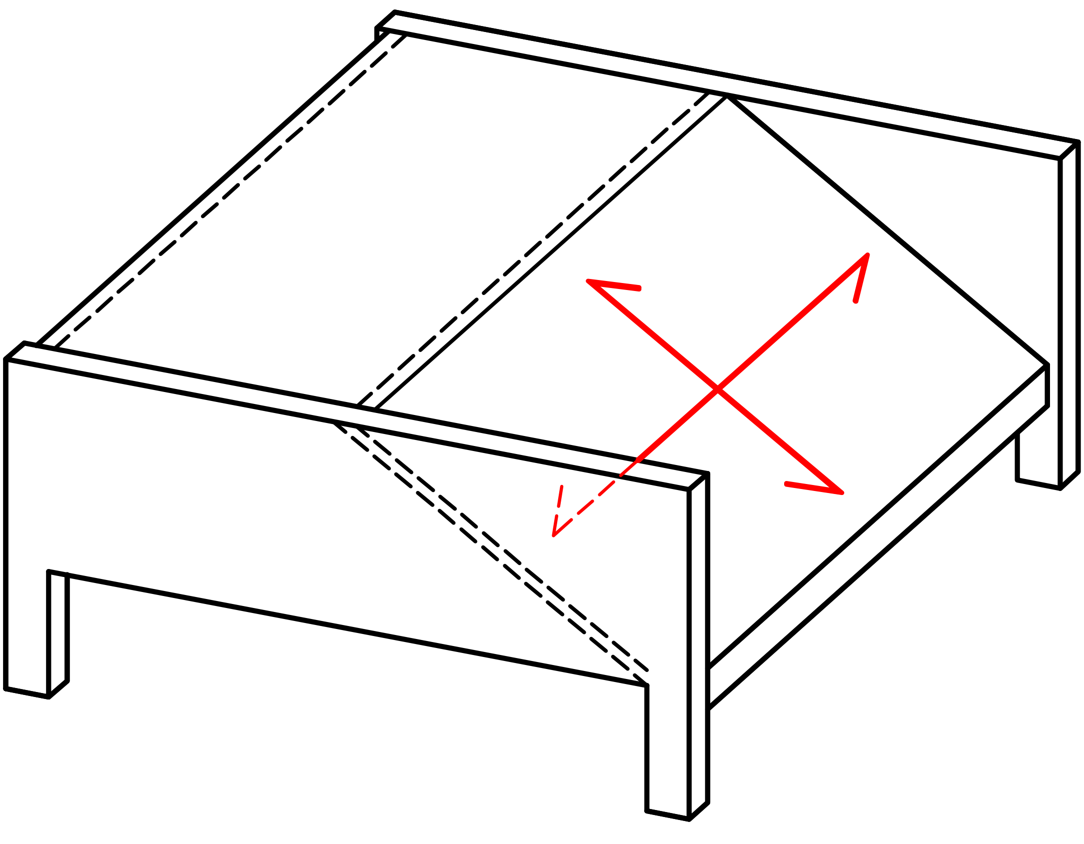
2.0
الكمره ليست مائله مع البلاطه
فتكون البلاطه محموله على كمرتين فقط
فتكون البلاطه one way
4.0
4.0
6.0



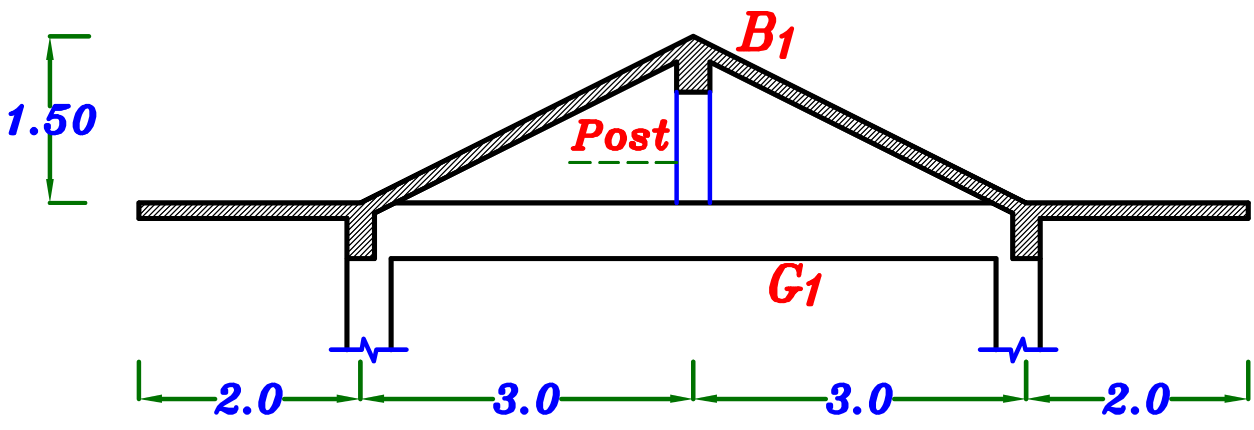
Note.



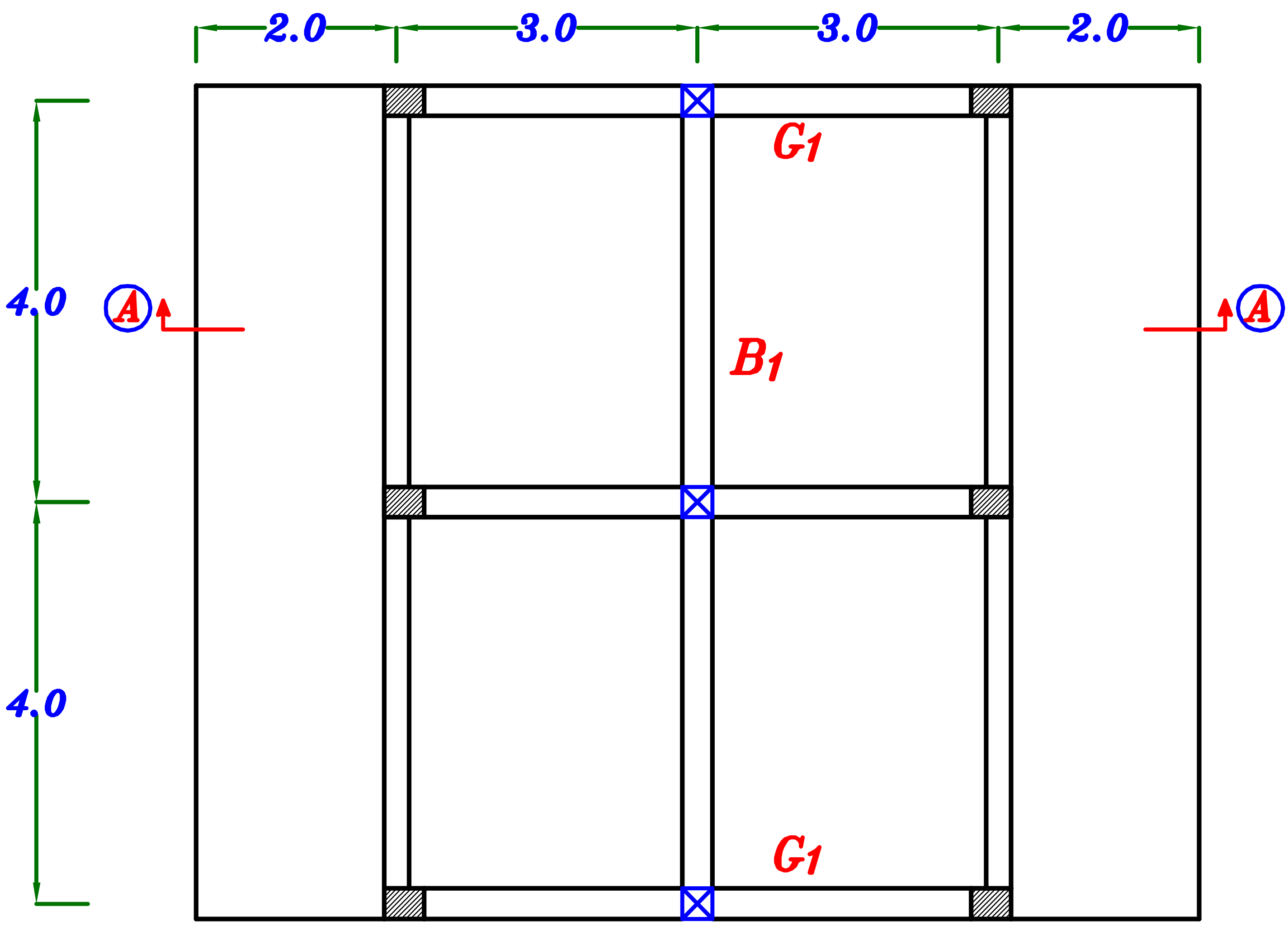
2.0
الكمره ليست ماثله مع البلاطه
لكن البلاطه كلها داخل تخانه الكمره
فتكون البلاطه محموله على ٤ كمرات
فتكون البلاطه two way
4.0
4.0
6.0



Note.



Sec. (A–A)

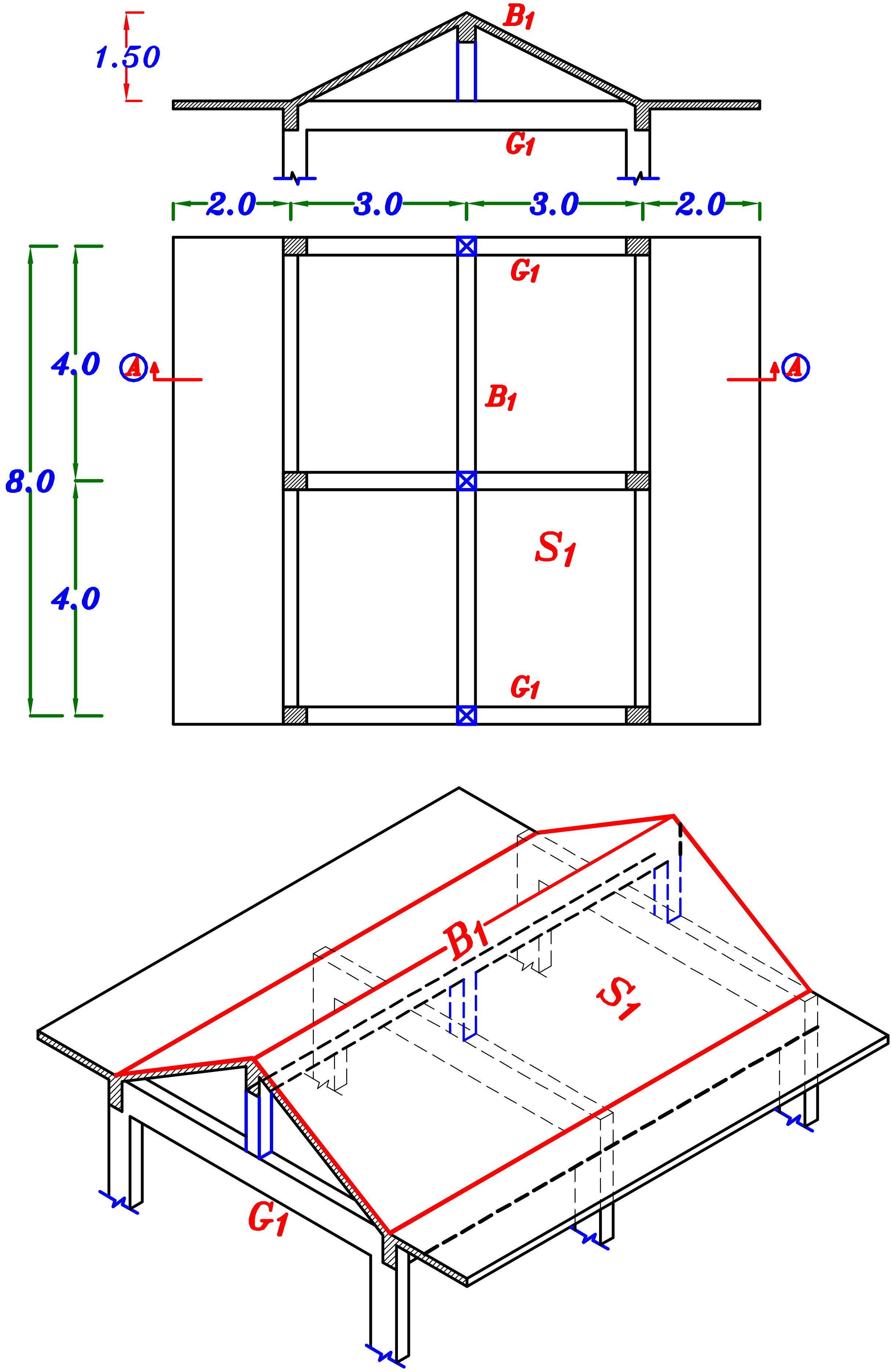


Plan

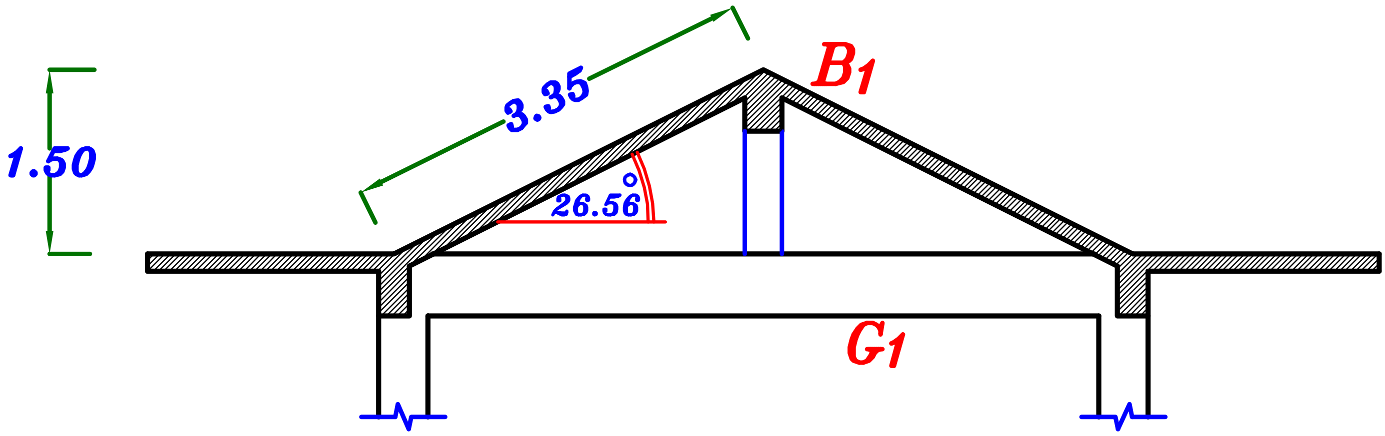
كما هو ظاهر من ال Cross Section

أن البلاطه المائله محموله على كمرتين فقط و ليست محموله على ال Girders

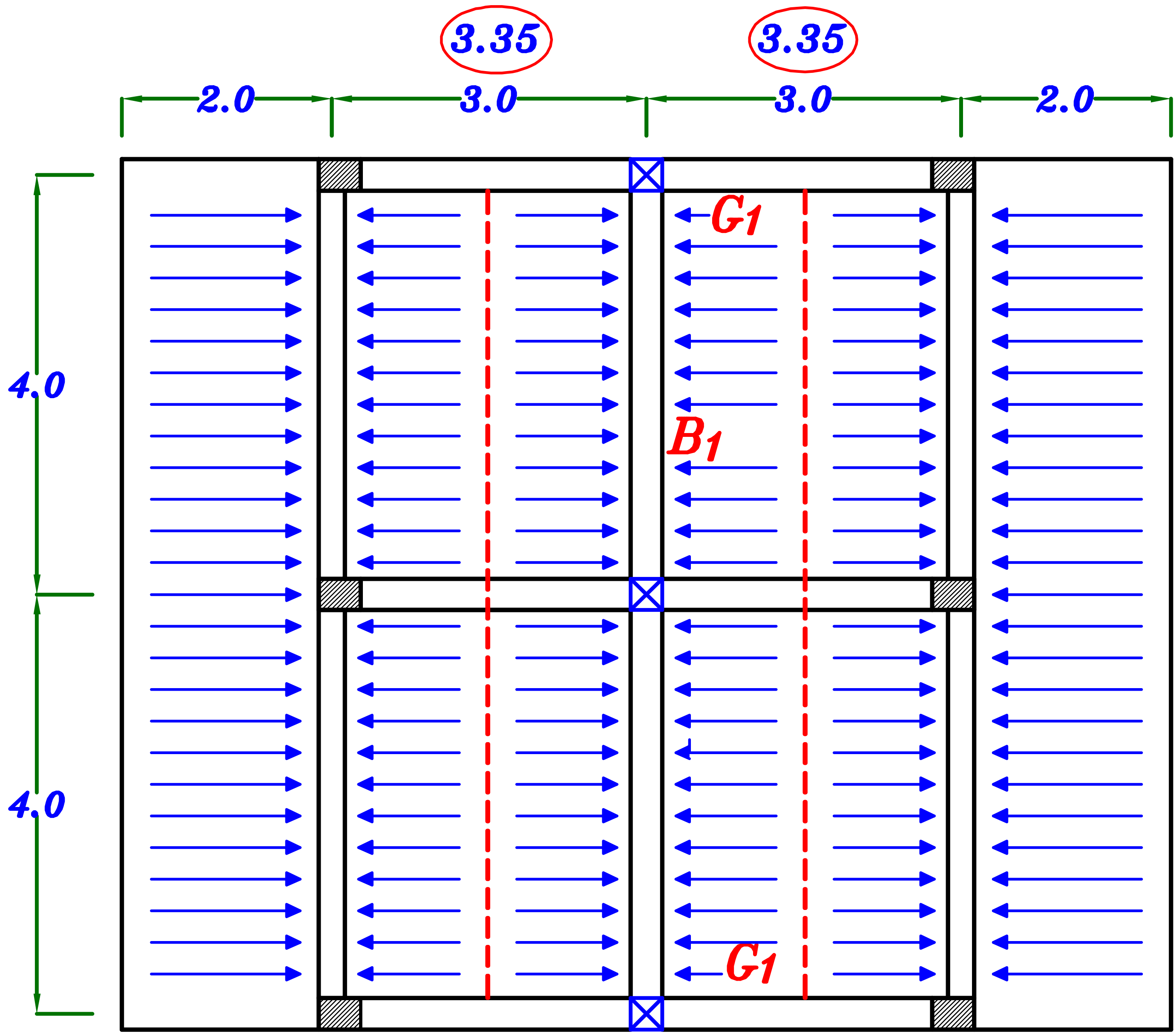
لذا فالبلاطه المائله تعتبر بلاطه One way



البلاطه S_1 محموله على كمرتين فقط و بالتالى فهى بلاطه **one way**

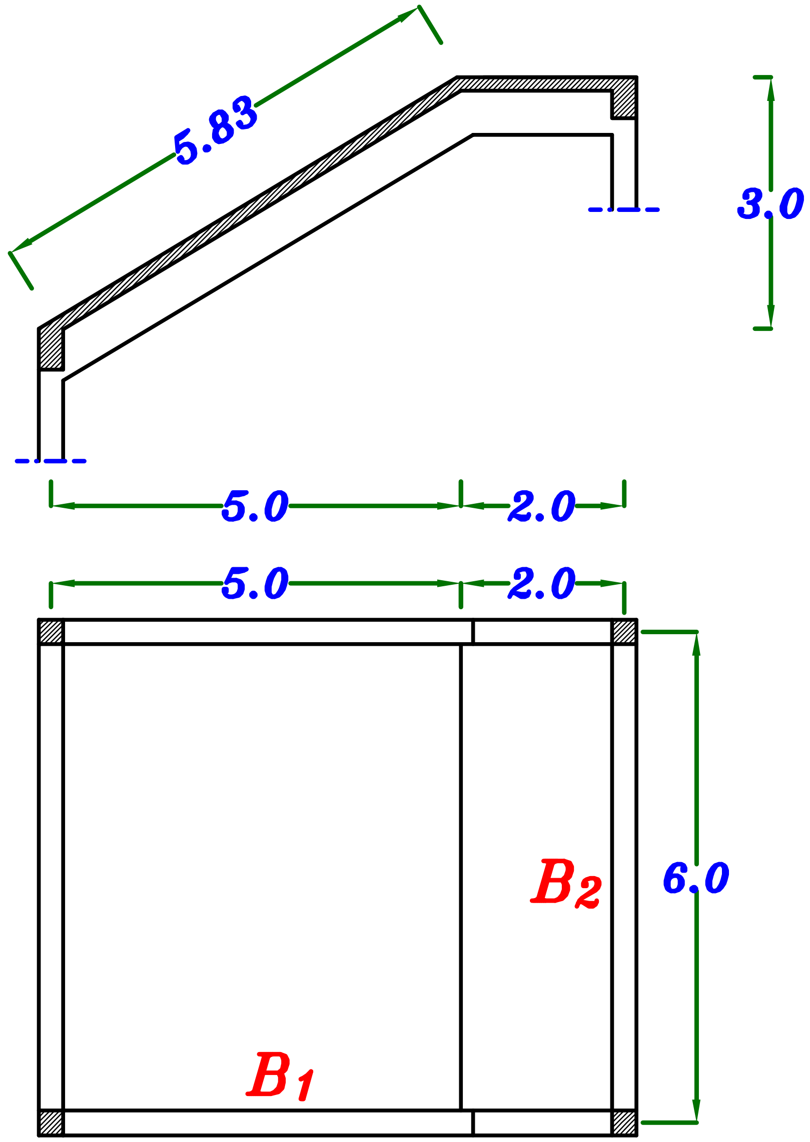


3.35
B1
1.50
26.56 o
G1



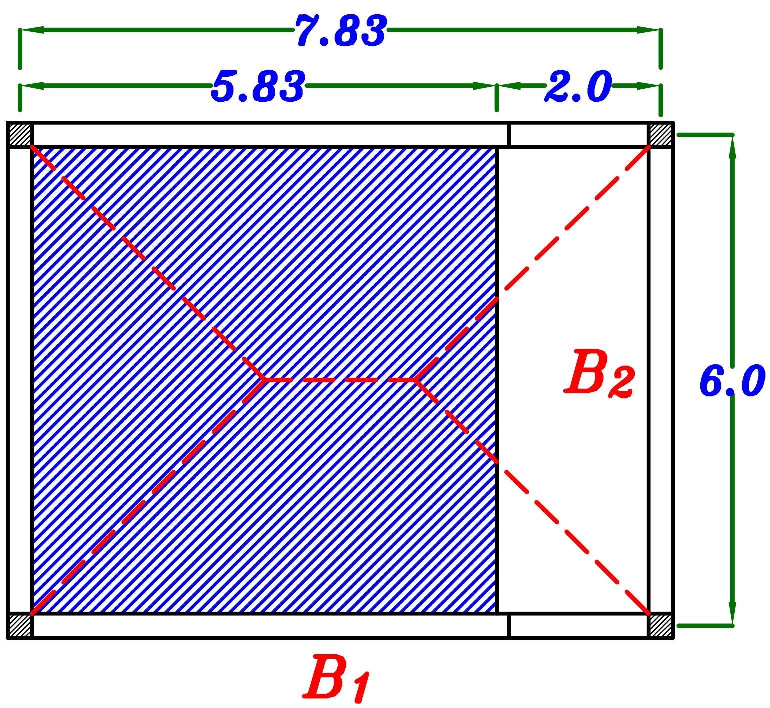
3.35
3.35
2.0
3.0
3.0
2.0
G1
4.0
B1
4.0
G1

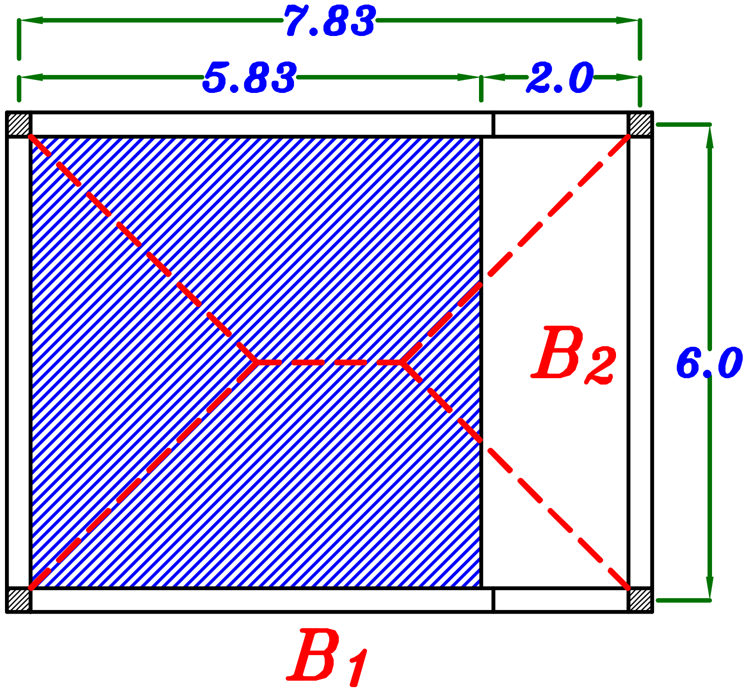
Example.



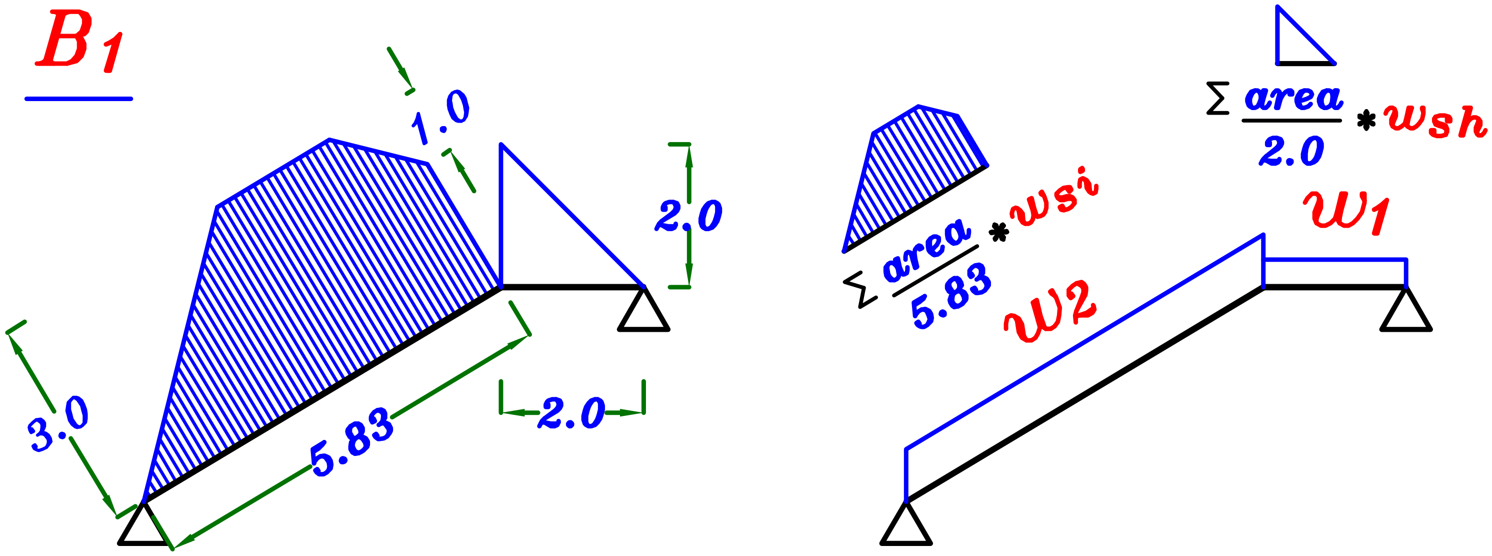
عند وجود كسره فى البلاطه (كما بالشكل) يتم رسم ال **plan** بالاطوال الحقيقيه

و عمل **Load Dist.** بالطريقه العاديه مع مراعاه اذا كان الحمل سيأخذ W_{sh} أم W_{si}

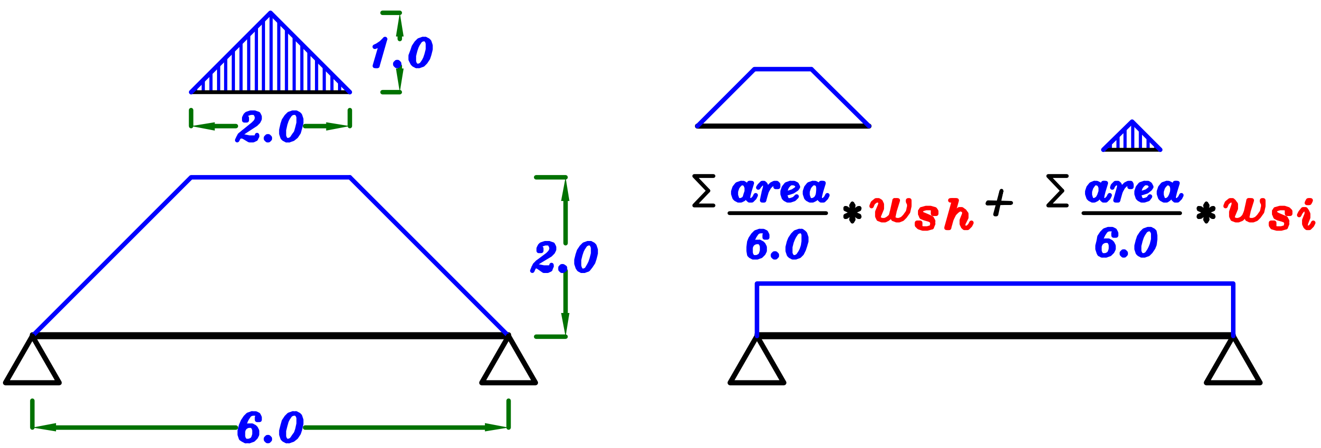



7.83
5.83
2.0
6.0
B2
B1

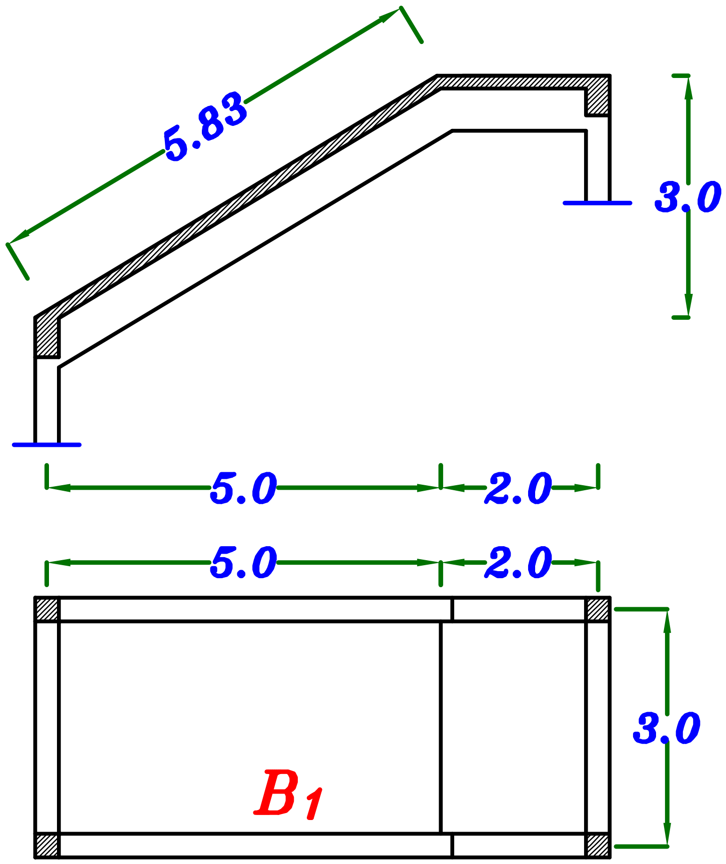
B1


1.0
2.0
3.0
5.83
2.0
Σ area / 2.0 * wsh
W1
Σ area / 5.83 * wsi
W2

B2

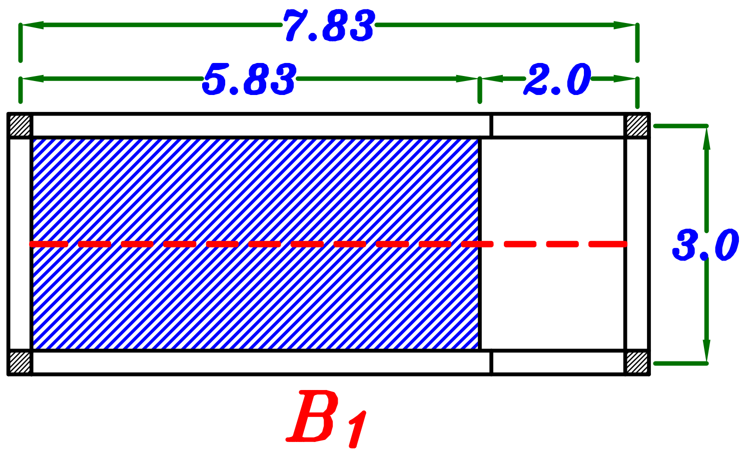

1.0
2.0
2.0
6.0
Σ area / 6.0 * wsh + Σ area / 6.0 * wsi

Example.

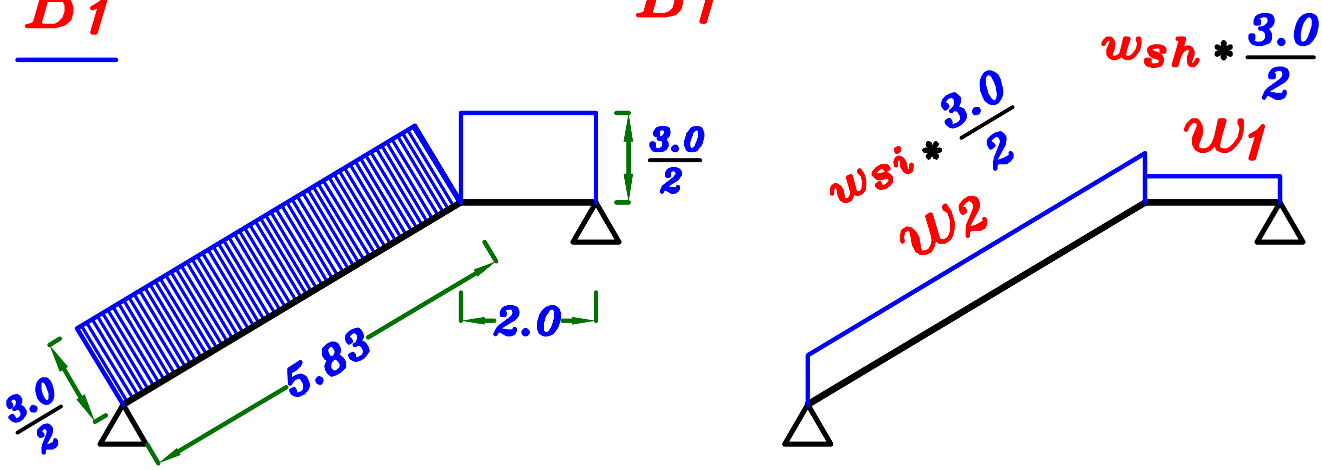


عند وجود كسره فى البلاطه (كما بالشكل) يتم رسم الـ plan بالاطوال الحقيقيه

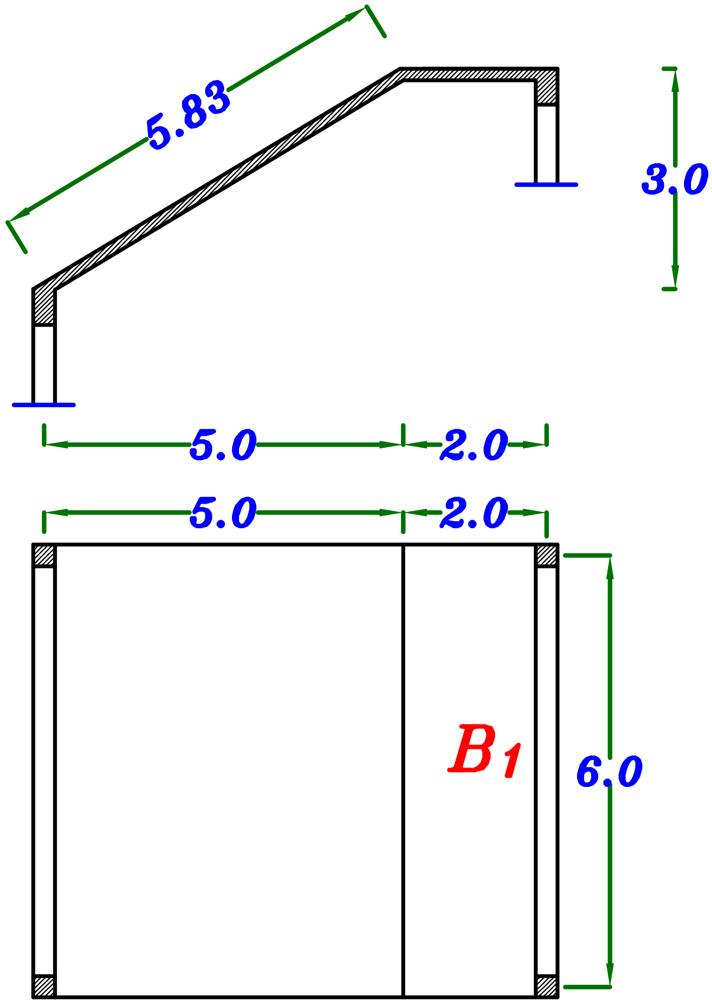
و عمل Load Dist. بالطريقه العاديه مع مراعاه اذا كان الحمل سيأخذ Wsh أم Wsi



B1



Example.

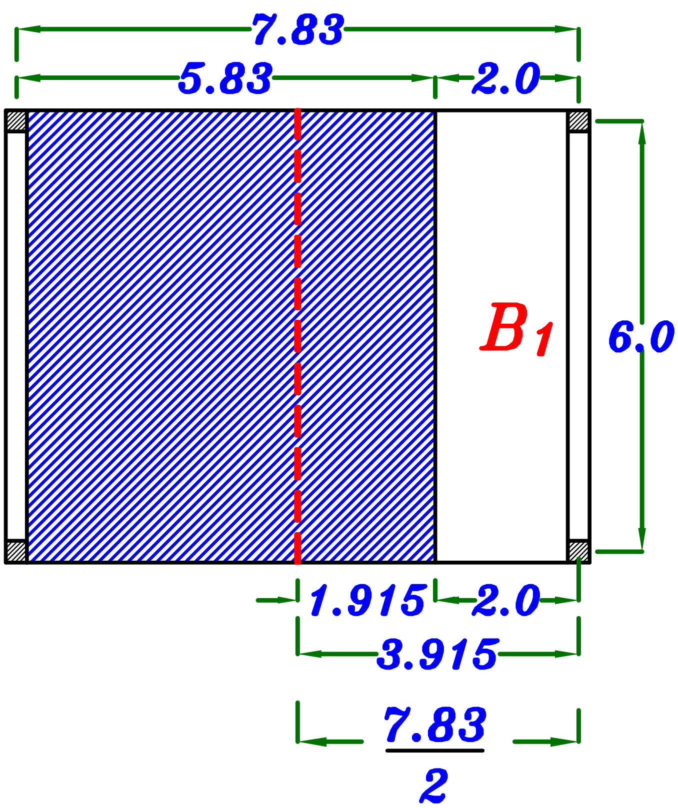


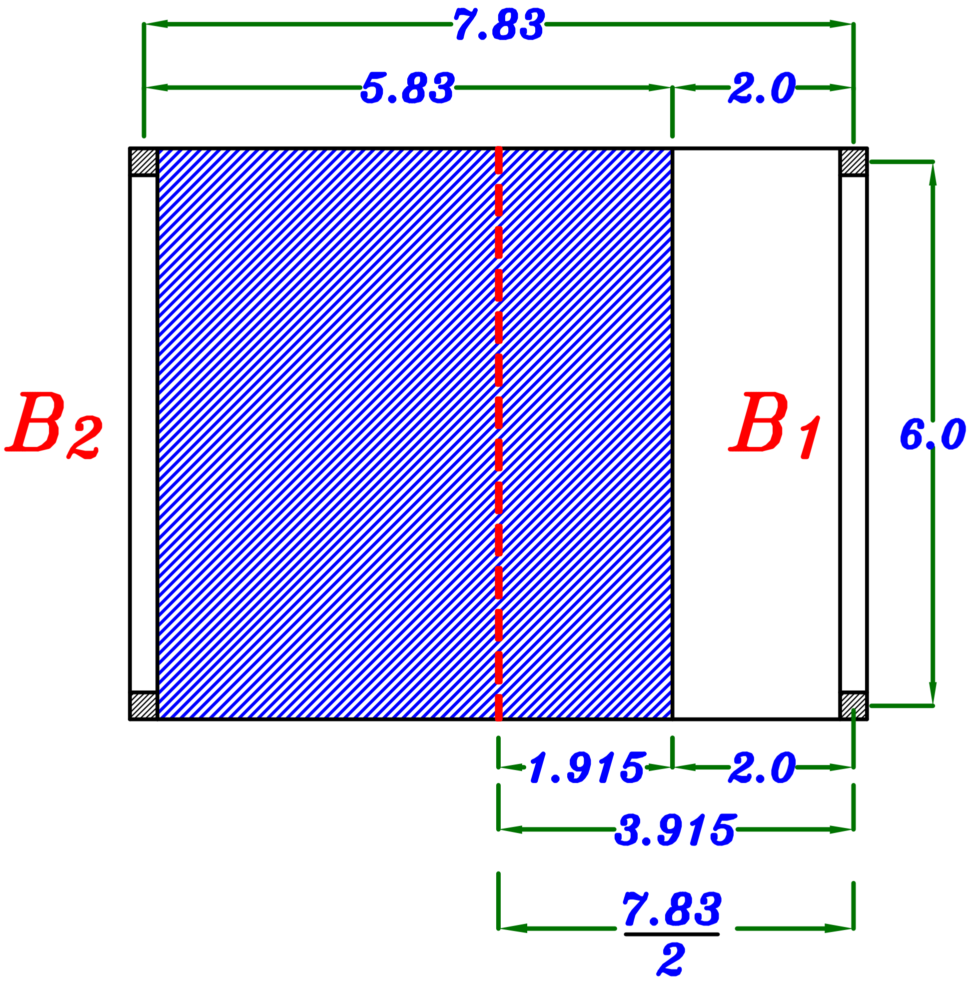
عند وجود كسره فى البلاطه (كما بالشكل) يتم رسم ال **plan** بالاطوال الحقيقيه

و عمل **Load Dist.** بالطريقه العاديه مع مراعاه اذا كان الحمل سيأخذ **Wsh** أم **Wsi**

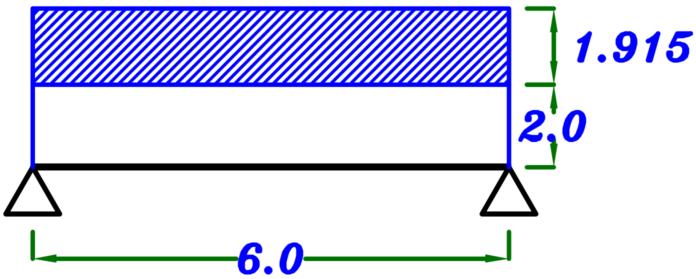
لان البلاطه محموله على كمرتين فقط

اذا ستكون **One way slab**

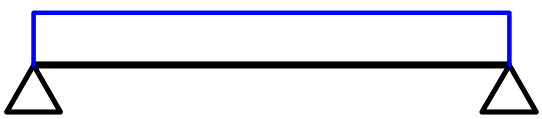




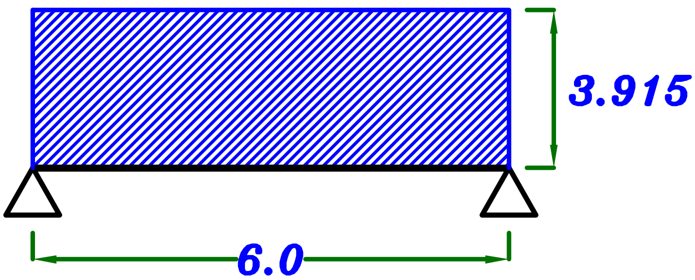
B_1



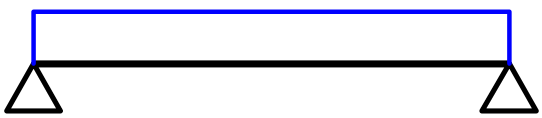
$w_{sh} * 2.0 + w_{si} * 1.915$



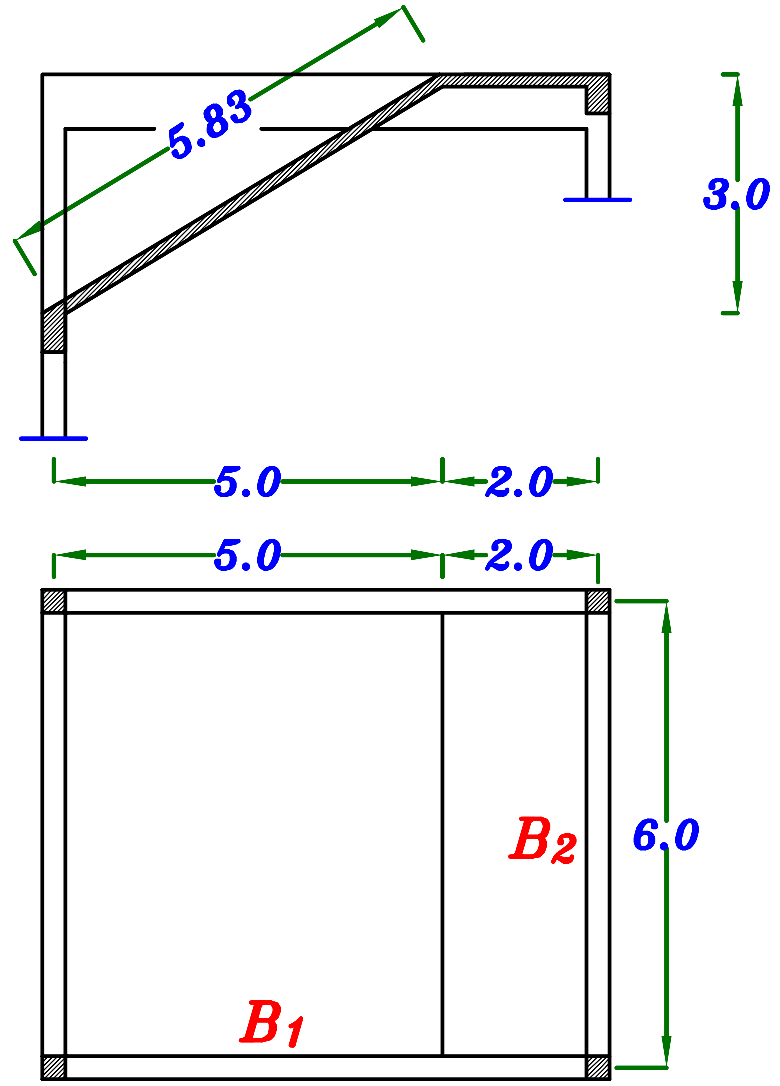
B_2



$w_{si} * 3.915$



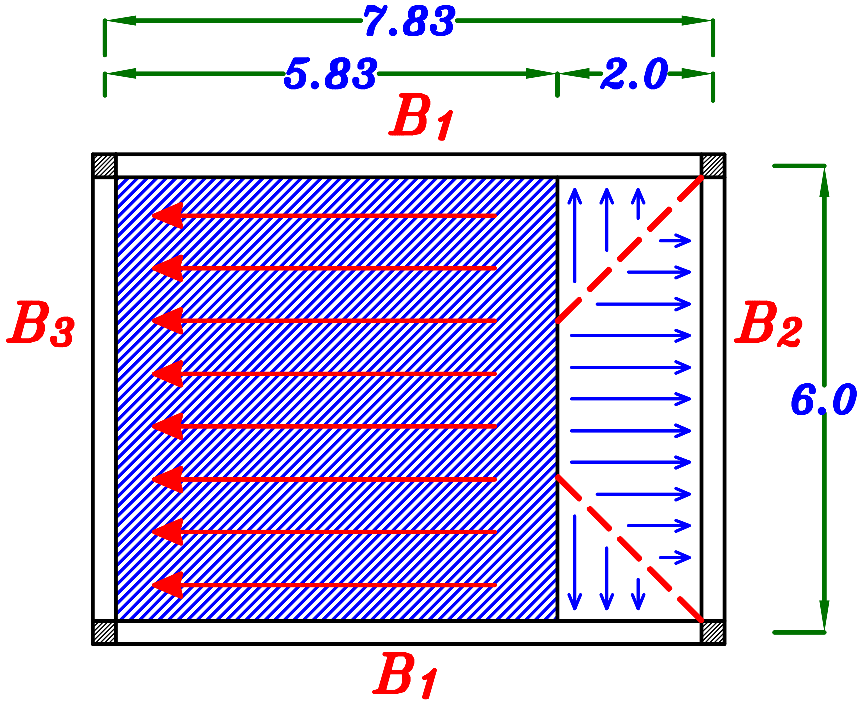
Example.

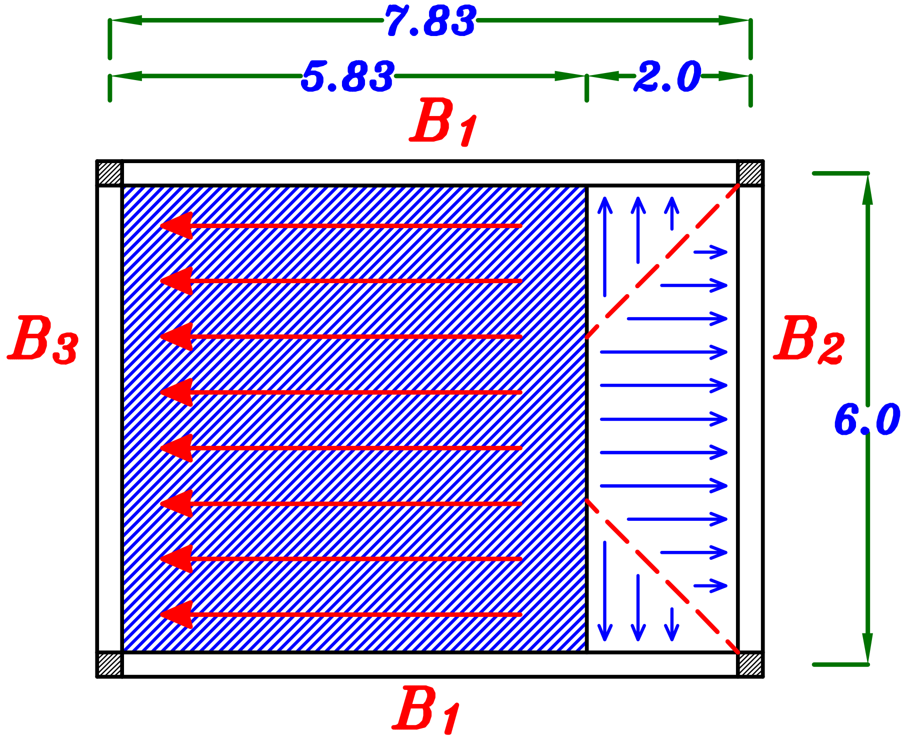


لان الكمره B_1 افقيه اى انها تمس الجزء الافقى من البلاطه فقط اذا فهى تحمل الجزء الافقى فقط.

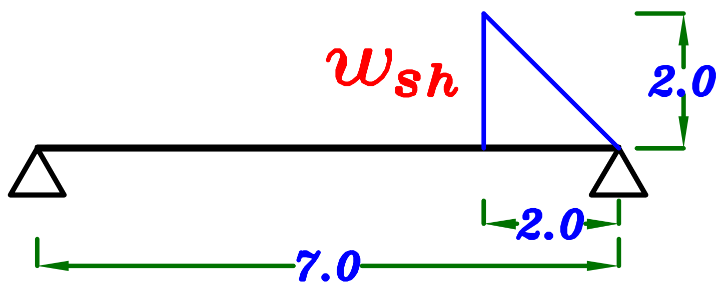
اما الجزء المائل من البلاطه فهو لا يمس الكمره B_1 لذا فهو ليس محمول عليها

و لان الجزء المائل من البلاطه يمس فقط الكمره B_3 اذا فهو محمول عليها فقط.

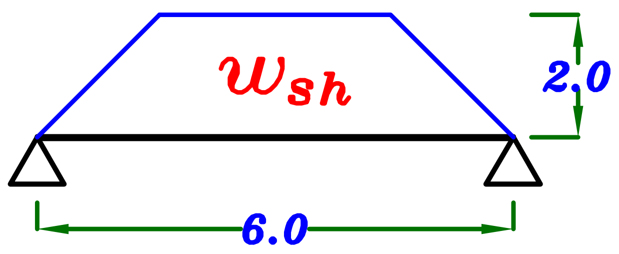




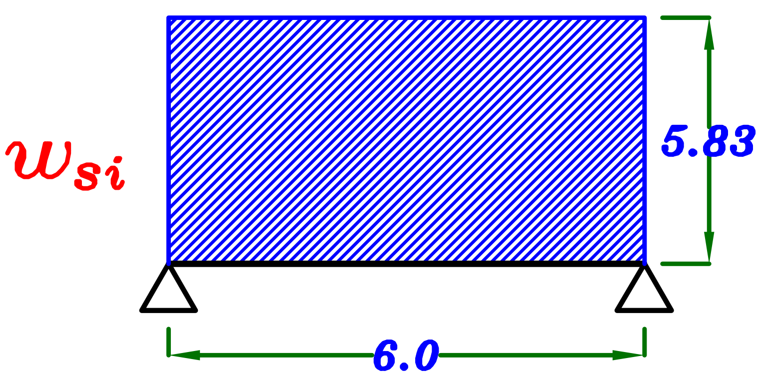
B_1



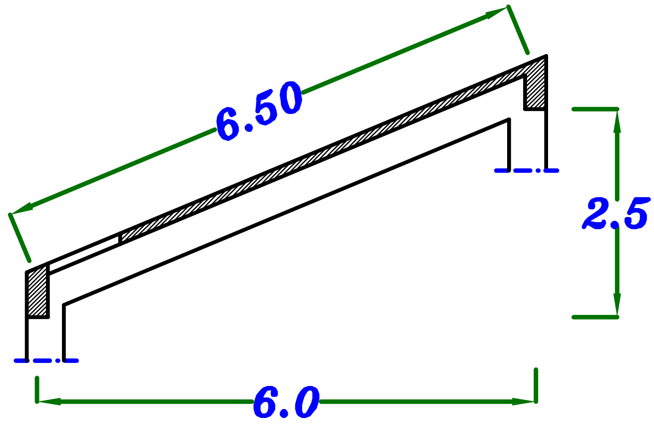
B_2



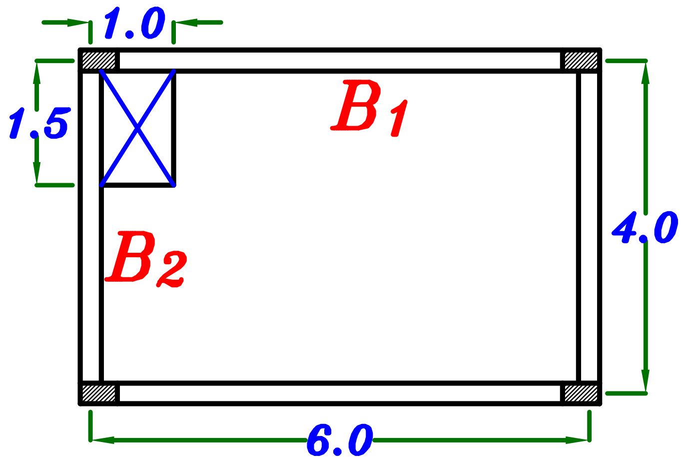
B_3

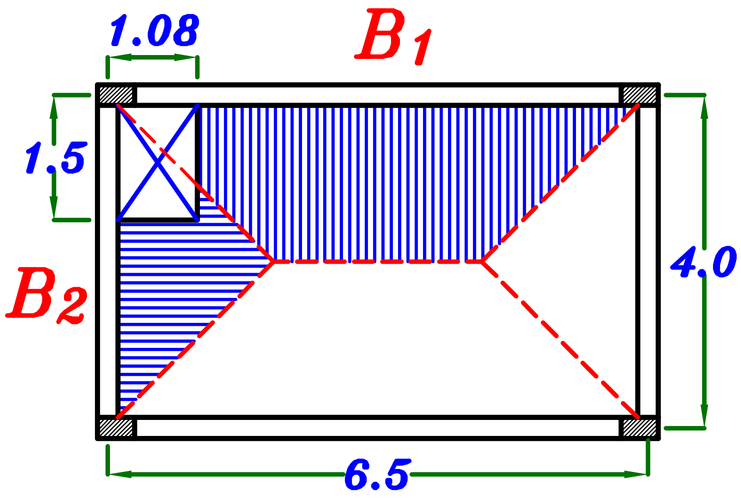


Example.



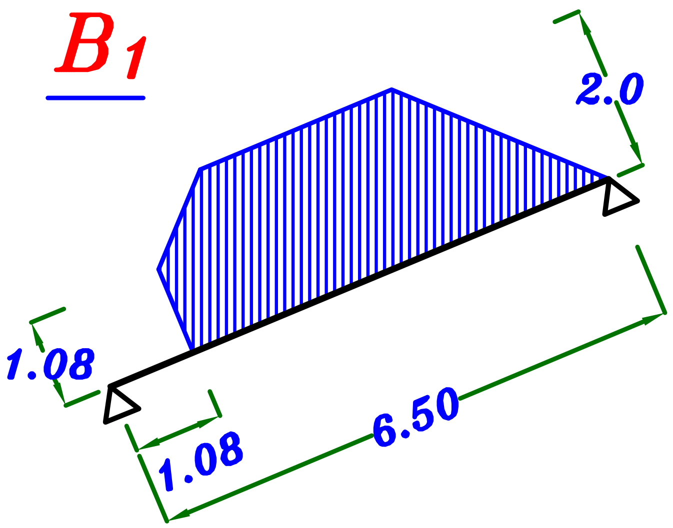
عند وجود Void ليس محاط بكمرات نعمل على عمل Load Dist. بتقسيم البلاطه بتنصيف الزوايا بين الكمرات ثم طرح مساحه الا Void



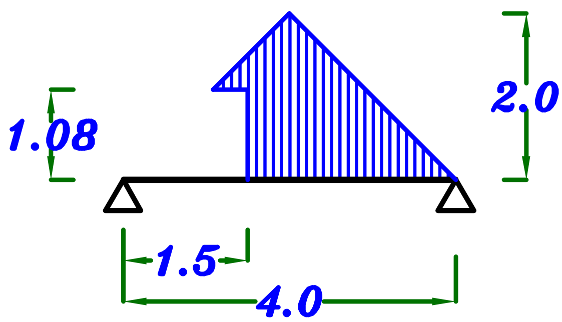


الاطوال الحقيقيه

B_1



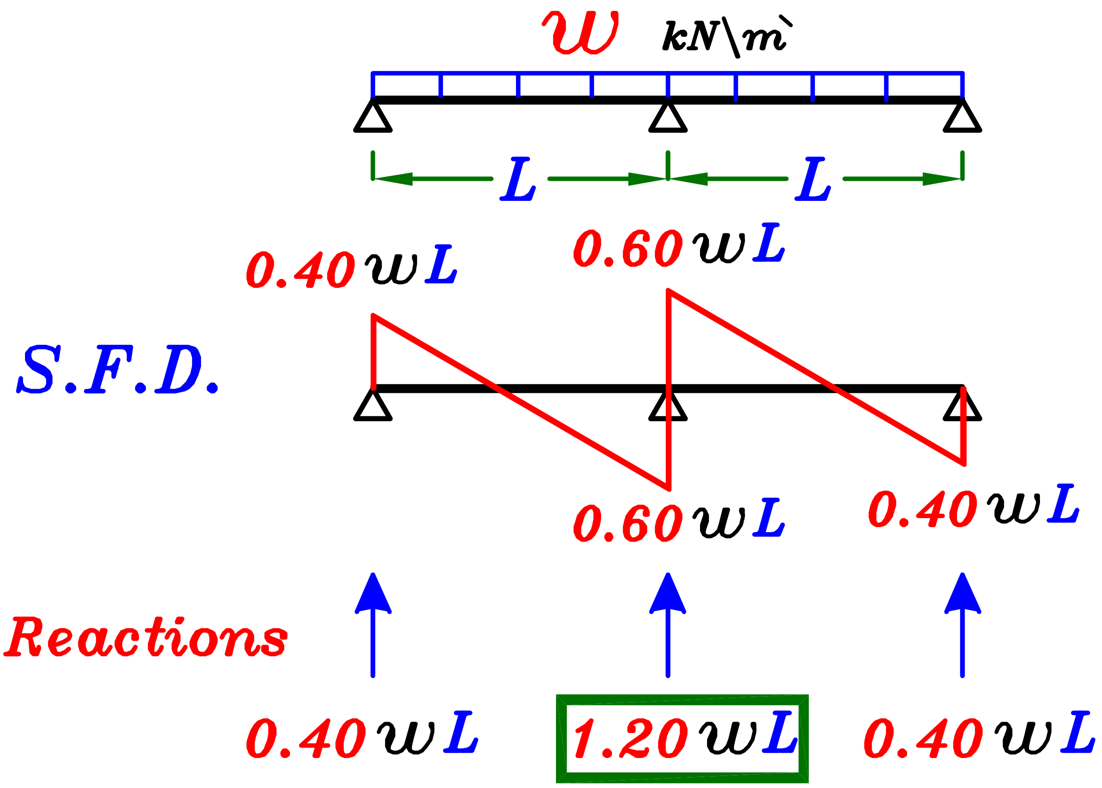
B_2



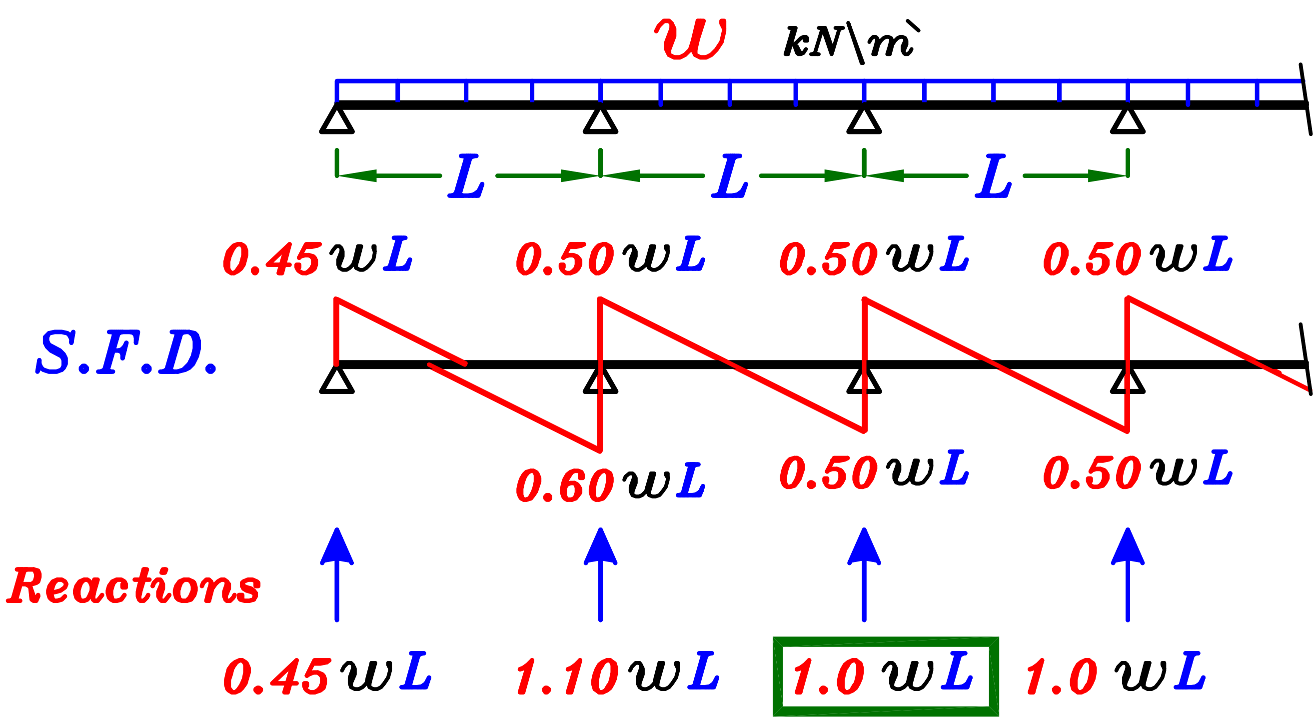
Reactions of Continuous Beams.

لحساب Reactions الكمرات ال Continuous سنحتاج لحلها بطريقه من طرق حل ال indeterminate structures
لكن اذا كانت البحور متساويه (equal spans) و الاحمال متساويه (equal loads) فمن الممكن استخدام القيم التاليه

① Continuous Beam with 2 spans.



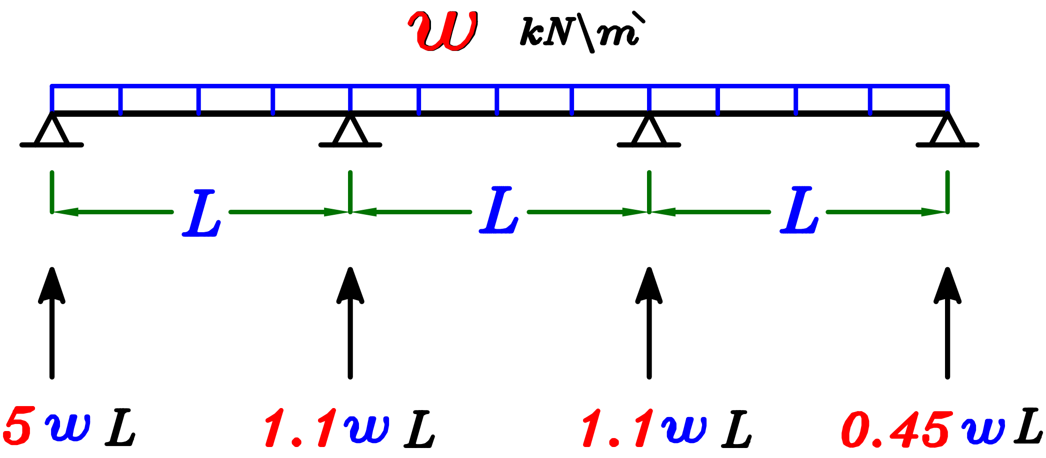
② Continuous Beam with more than 2 spans.



3 Spans

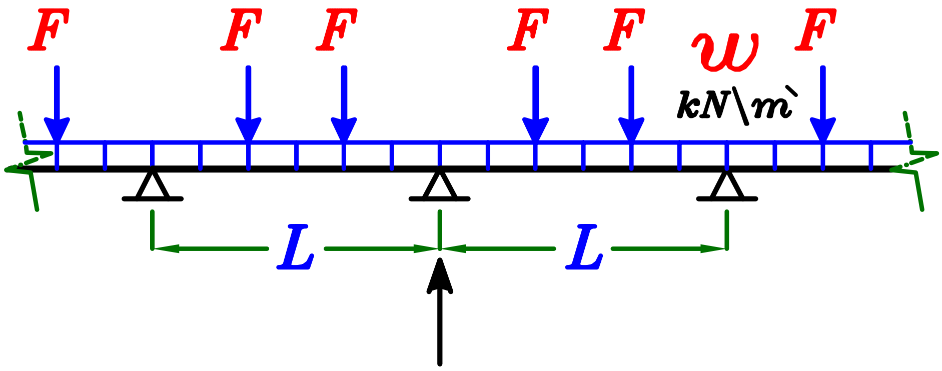
Constant Load & equal spans.

Reactions.



More than 2 Spans

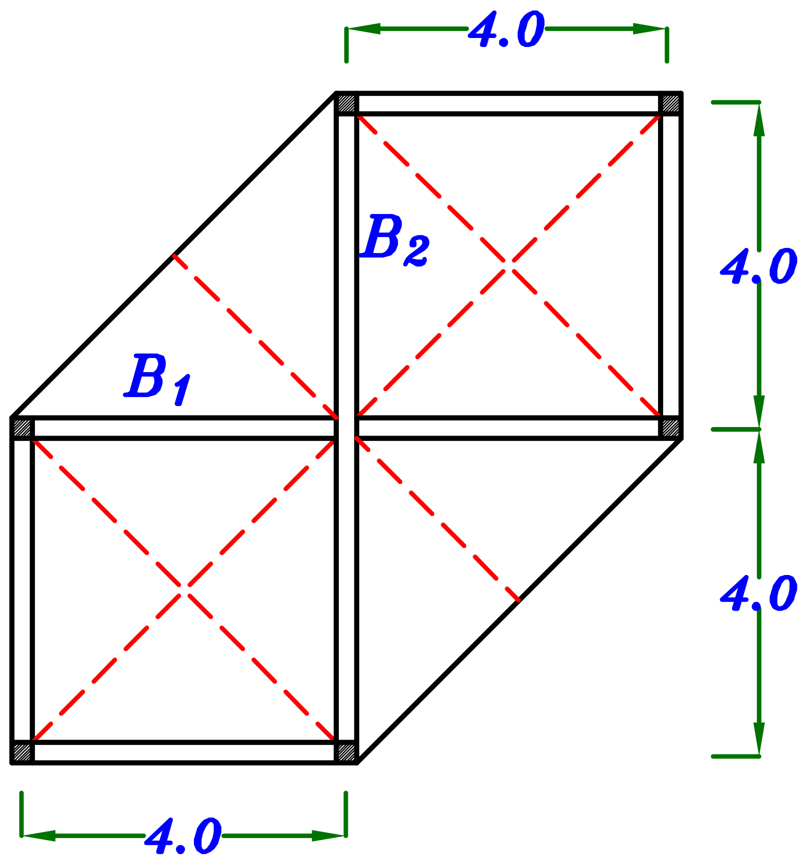
Constant Load & equal spans.



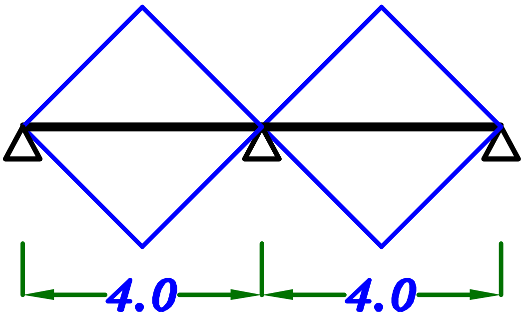
R = Total Load on one span

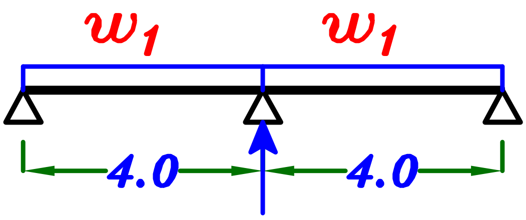
$= w * L + 2F$

Example.



B_1

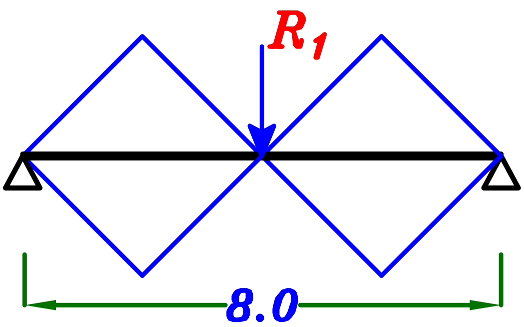


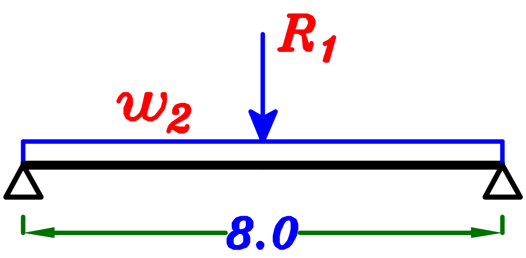


$$R_1 = 1.2\ w_1\ L$$
$$1.2\ w_1\ (4.0)$$

$$w_1 = O.W. + 2.0\left[\frac{C_a}{C_e}\ w_s\ \frac{L_s}{2}\right]$$

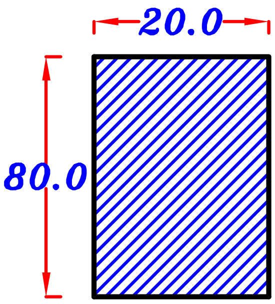
B_2





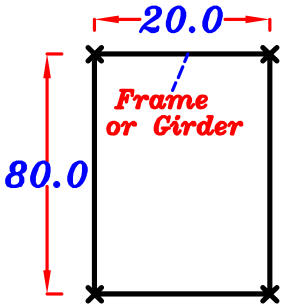
$$w_2 = O.W. + \frac{\sum area}{Span} * w_s = O.W. + \frac{(4*0.5*4*2)}{(8.0)} * w_s$$

Cross Sections مسائل ال

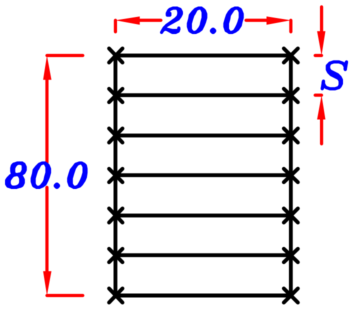


لعمل تغطيه (سقف) للمساحات الكبيره مثل المصانع بدون وضع أعمده داخليه .

يتم عمل الاتى :

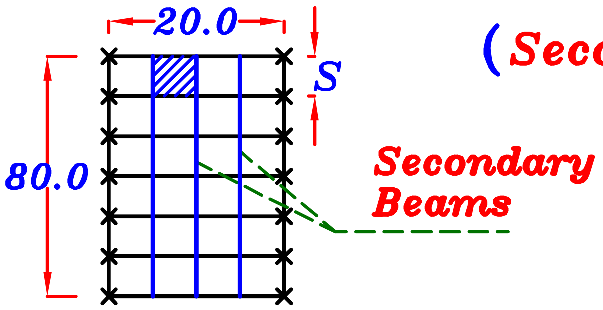


١ـ يتم وضع ***Frame*** أو ***Girder*** (كمره كبيره)
في الاتجاه القصير للارض .



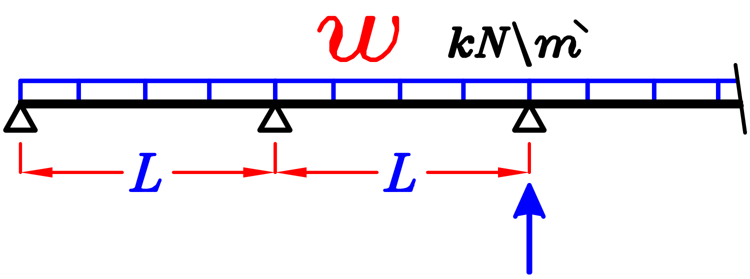
٢ـ يتكرر كل مسافه تسمى *Spacing*

$$Spacing\ (S) \simeq (4.0 \rightarrow 8.0\,m)$$



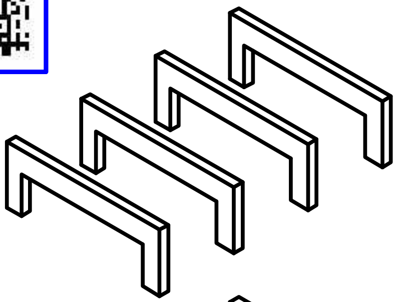
٣ـ نضع كمرات ثانويه **(Secondary Beams)**
محموله على ال ***Girder***
و ذلك لتقليل مساحات البلاطات

٤ـ لان الكمرات الثانويه محموله على ال ***Girder***
فيجب حساب ال ***Reactions*** لها أولا
و لان الكمرات الثانويه تعتبر كمرات *Continuous Beams with more than 2 spans*
فيكون ال ***Reaction*** لها
يساوى $\boxed{w * S}$

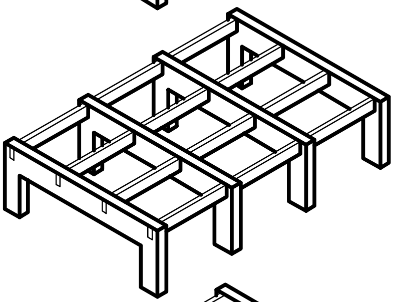


$$\boxed{1.0\ wL = w * S}$$

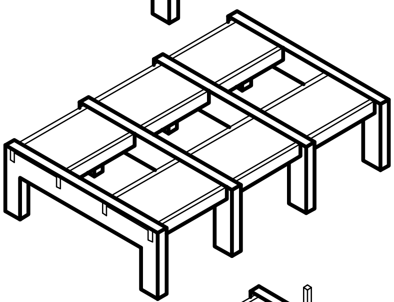
Sky Light الشخشيخه



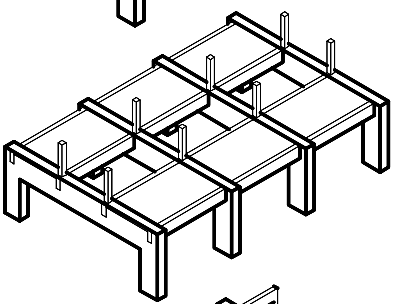
١- يتم تكرار الـ **Girder** كل **Spacing**



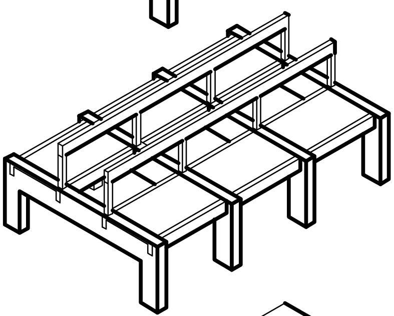
٢- يتم وضع الكمرات الثانويه محموله على الـ **Girder**



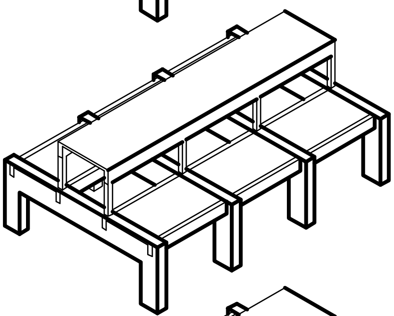
٣- توضع البلاطات محموله على الـ **Girder** و الكمرات الثانويه



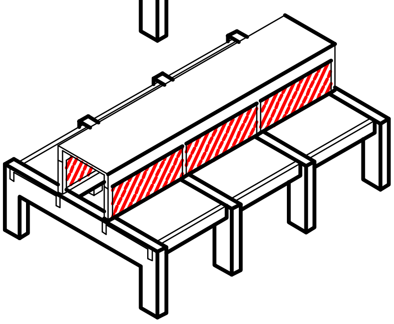
٤- يتم وضع أعمده قصيره تسمى (شمعه) **Post** و تكون محموله على الـ **Girder** و يكون شكلها فى الـ **Cross section** ⊠



٥- توضع كمرات ثانويه محموله على الـ **Posts**



٦- توضع بلاطه محموله على الكمرات الثانويه العلويه



٧- توضع الشبابيك بين الـ **Posts**

ما الفارق بين ال Frame و ال Girder ؟ ؟

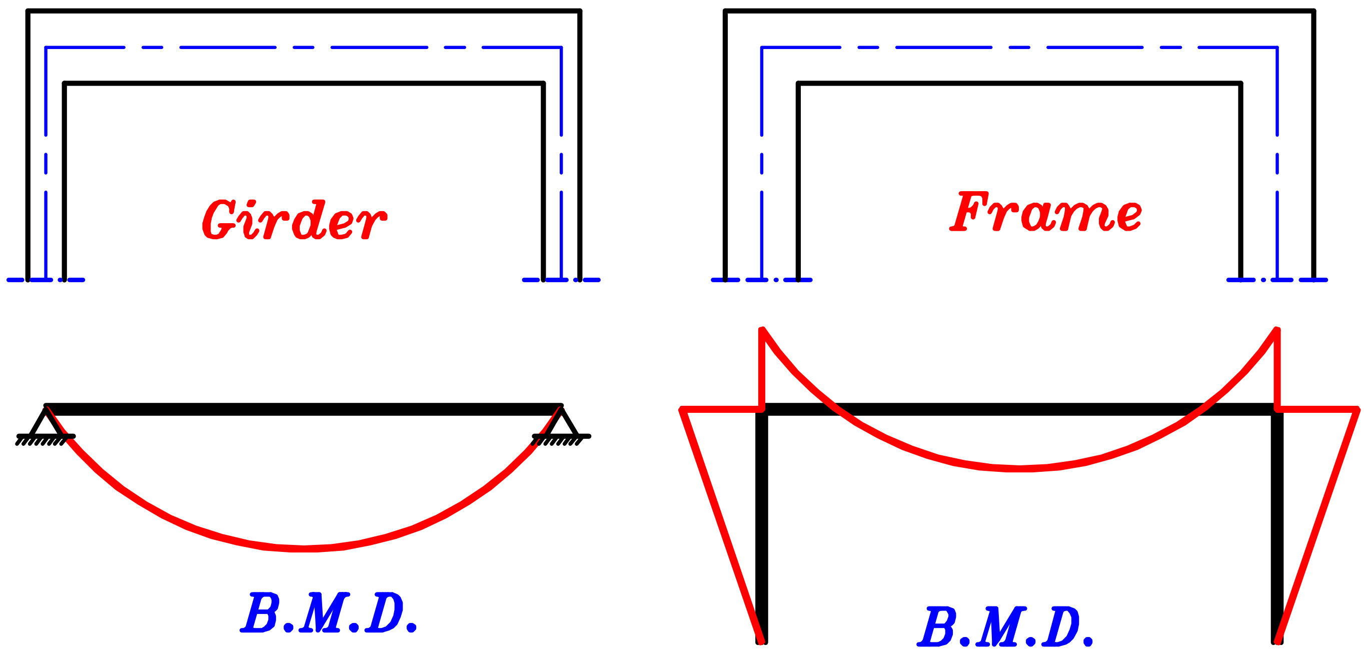
كلاً من ال **Frame** و ال **Girder** عباره عن كمره محموله على عمودين

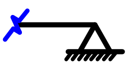
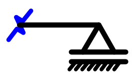
لكن الفرق بينهم أن فى ال **Frame** الاعمده سميكه أى ان ال **stiffness** للاعمده قريب من الكمرات

و تفصيله الحديد بينهم تعمل على نقل العزوم من الكمره للعمود **Rigid joint**

أما ال **Girder** فأعمدته نحيفه نسبيا أى أن ال **stiffness** للاعمده أقل كثير من الكمرات

و تفصيله الحديد بينهم لا تعمل على نقل العزوم من الكمره للعمود **Hinged joint**



فى ال **Girder** نهمل الاعمده و نضع بدلا منها **support**  أو 

أما فى ال **Frame** فيجب اعطائنا ال **statical system** فى المسأله

ملحوظه

ممكن اهمال ال **Reaction** الكمرات الثانويه الموجوده فوق الاعمده مباشره فى ال **Girder**

و لكن يجب أخذها فى الاعتبار مع ال **Frame** لرسم ال **N.F.D.** على الاعمده

خطوات مسأله ال cross-section (Total Load)

١- نستنتج ال Plan

٢- نرسم خطوط توزيع ال Loads (Load Distribution)

٣- نسمى الكمرات ...... B_1 , B_2 , B_3

٤- نحسب w_s

٥- نحسب Load For Shear للكمرات الثانويه و نحدد ال Reactions.

$$\boxed{R = w * S}$$

٦- نضع الاحمال على ال Girder بالترتيب التالى :-

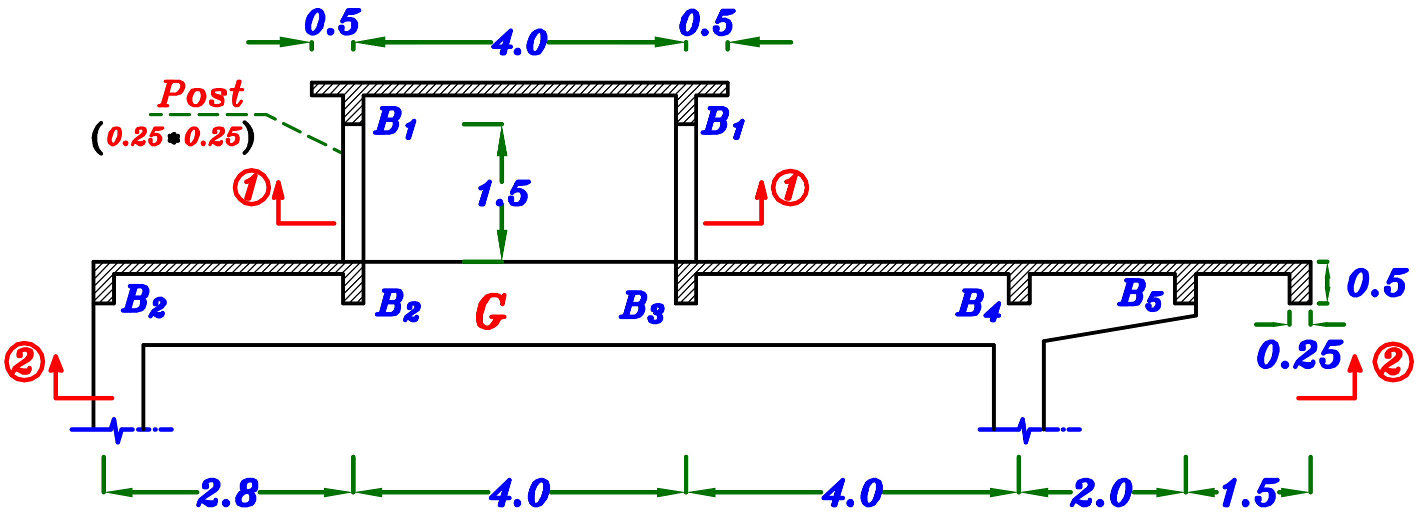
أ - نضع o.w. على ال Girder كله .

ب - نضع Reactions الكمرات الثانويه concentrated loads على الGirder

ج - نضع أحمال البلاطه التى تنتقل مباشره من البلاطه الى ال Girder .
و تظهر هذه الاحمال من ال plan.

٧- نرسم B.M.D. & S.F.D. للGirder

Example.



$t_s = 120$ mm

$F.C. = 1.50$ kN\m², $L.L. = 2.0$ kN\m²

O.W. of beams $= 3.0$ kN\m`, O.W. of Girder $= 6.0$ kN\m`

Spacing $= 6.0$ m

Req. Draw S.F.D. & B.M.D. For the girder (G).

Case of Total Load is only required.

$$w_s = t_s * \gamma_c + F.C. + L.L.$$

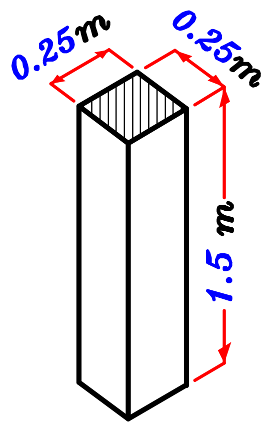
$$= 0.12 * 25 + 1.50 + 2.0 = 6.50 \ kN\backslash m^2$$

$$\boxed{w_s = 6.50 \ kN\backslash m^2}$$

Post

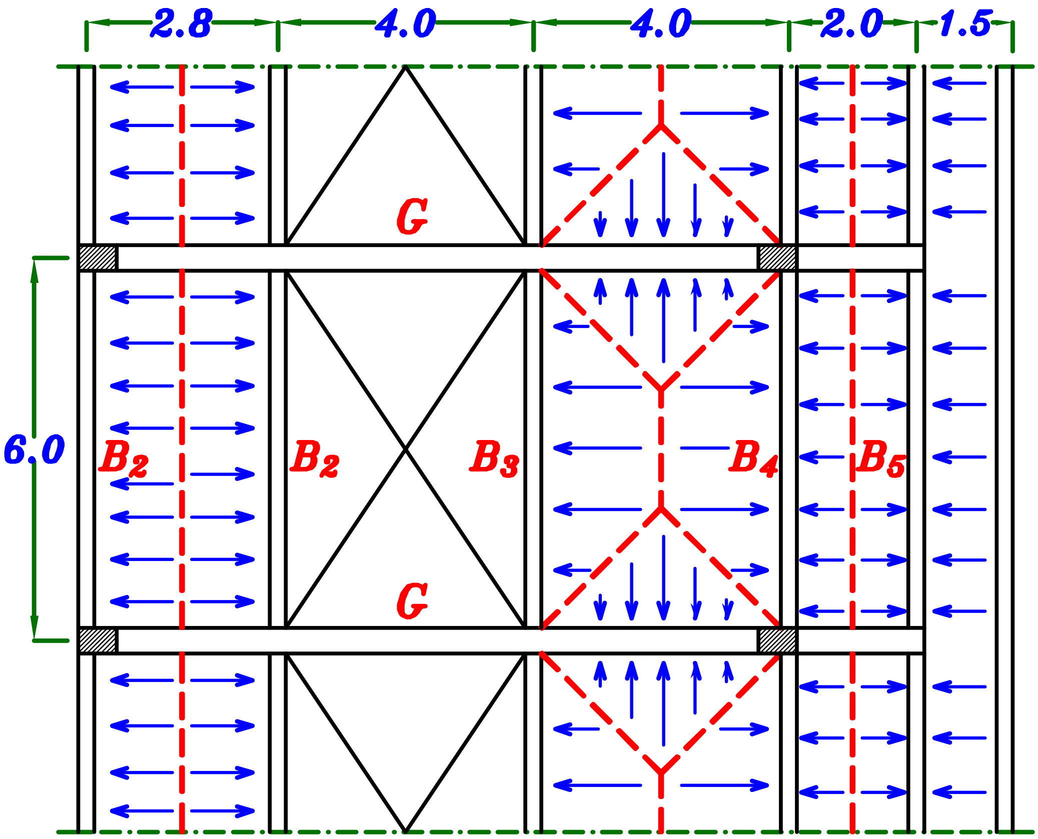
Weight of the Post = Volume * Density

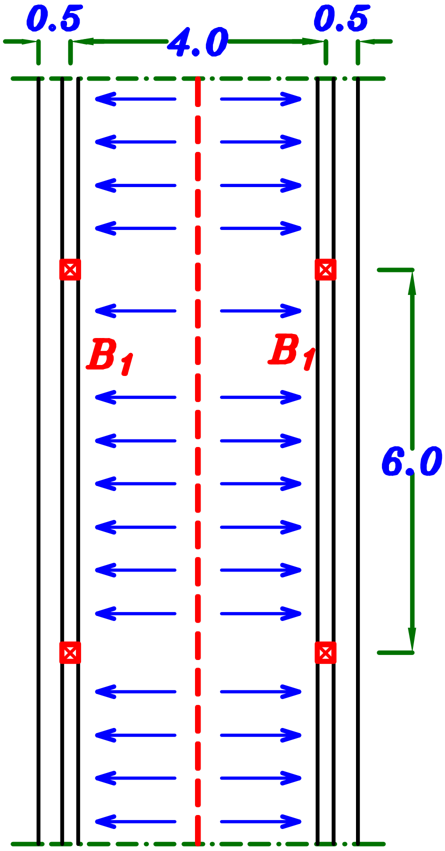
$$= (0.25 * 0.25 * 1.50)(25) = 2.34 \ kN$$



$$\boxed{\text{Weight of the Post} = 2.34 \ kN}$$

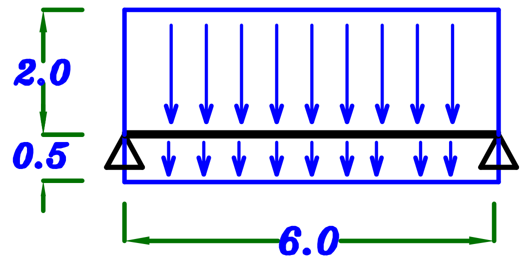
Note : Weight of Post can be neglected.





B_1

Load For Shear = Load For moment



$$w_a = w_e = O.W. + w_s L_c + w_s \frac{L_s}{2}$$

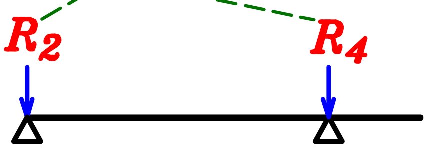
$$= 3.0 + (6.50)(0.5) + (6.50)\left(\frac{4}{2}\right) = 19.25 \ kN\backslash m`$$

$$R_1 = w_a * Spacing = 19.25 * 6.0 = 115.5 \ kN$$

$$\boxed{R_1 = 115.5 \ kN}$$

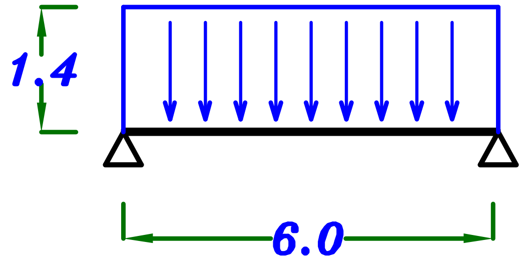
ملحوظه في مسائل ال **Girders** لن نحتاج لحساب **Reactions**
الكمرات الثانويه المحموله فوق الاعمده

هذه الاحمال تذهب مباشره الى الاعمده



B_2

Load For Shear = Load For moment



$$w_a = w_e = O.W. + \overline{w_s}\,\frac{L_s}{2}$$

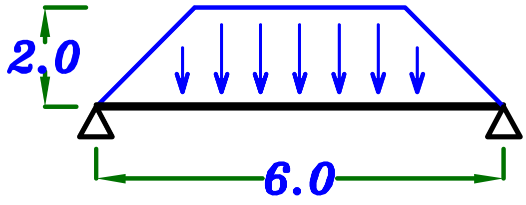
$$= 3.0 + (6.50)\left(\frac{2.8}{2}\right) = 12.10 \; kN\backslash m'$$

$$R_2 = 12.10 * 6.0 = 72.60 \; kN$$

$$\boxed{R_2 = 72.60 \; kN}$$

B_3

For Trapezoid



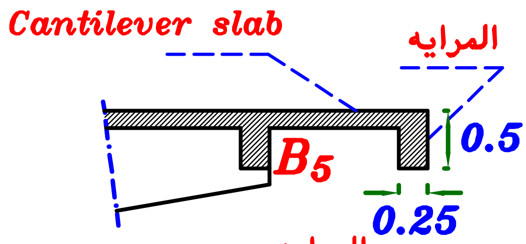
$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{6}\right) = \frac{2}{3}$$

$$w_a = O.W. + C_a\,\overline{w_s}\,\frac{L_s}{2} = 3.0 + \frac{2}{3}(6.50)\left(\frac{4}{2}\right) = 11.66 \; kN\backslash m'$$

$$R_3 = 11.66 * 6.0 = 70.0 \; kN$$

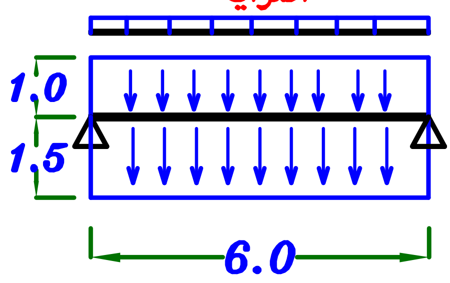
$$\boxed{R_3 = 70.0 \; kN}$$

B_5



وزن المرايه

$$b\; t\; \gamma_c = (0.25)(0.5)(25) = 3.12 \; kN\backslash m'$$



المرايه محموله على ال **Cantilever slab**
و ال **Cantilever slab** محموله على B_5

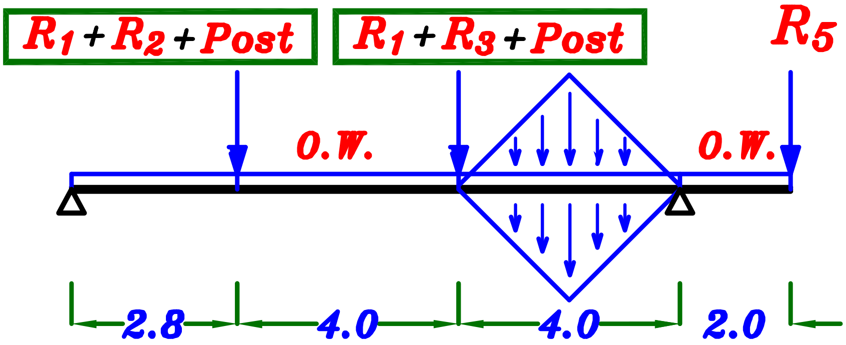
$$w_a = O.W.(\text{الكمره}) + O.W.(\text{المرايه}) + \overline{w_s}\,L_c + \overline{w_s}\,\frac{L_s}{2}$$

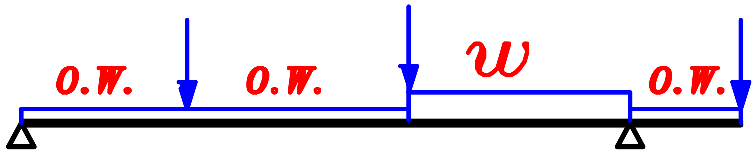
$$= 3.0 + 3.12 + (6.50)(1.5) + (6.50)\left(\frac{2}{2}\right) = 22.37 \; kN\backslash m'$$

$$R_5 = 22.37 * 6.0 = 134.22 \; kN$$

$$\boxed{R_5 = 134.22 \; kN}$$

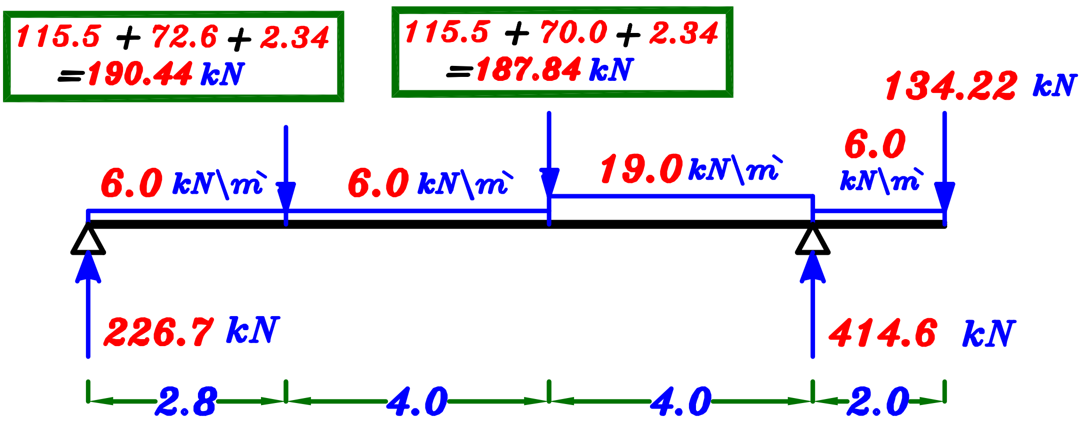
Girder (G)



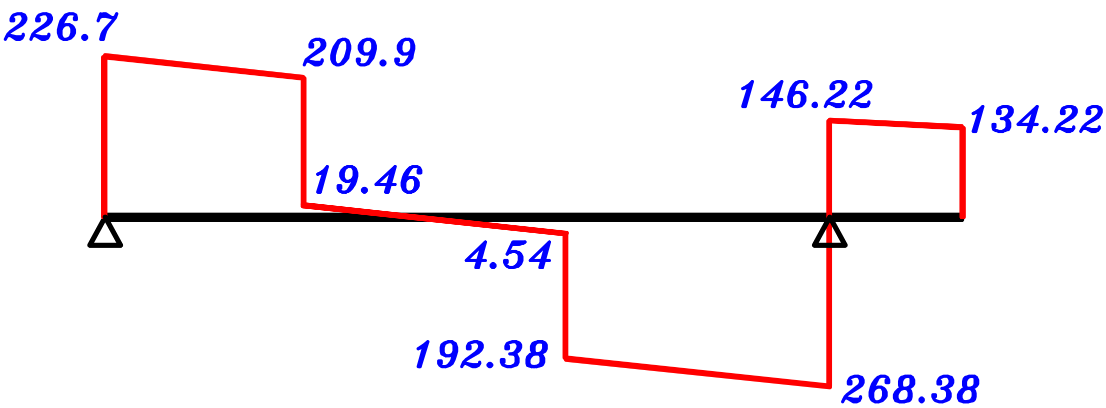


$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(4)(2)\right)}{4} = 2.0$$

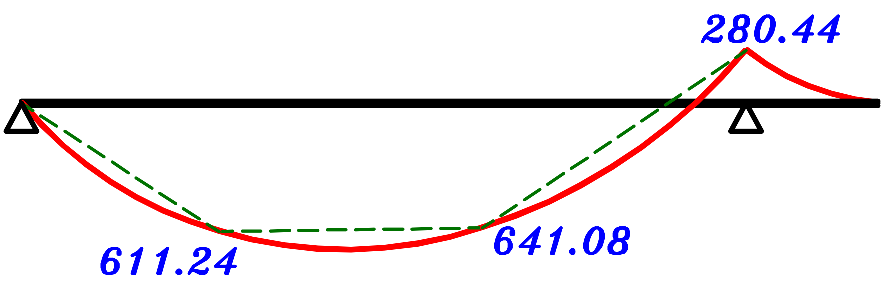
$$w_a = w_e = O.W. + \frac{\sum area}{span} * w_s = 6.0 + 2.0\,(6.50) = 19.0\ kN\backslash m`$$



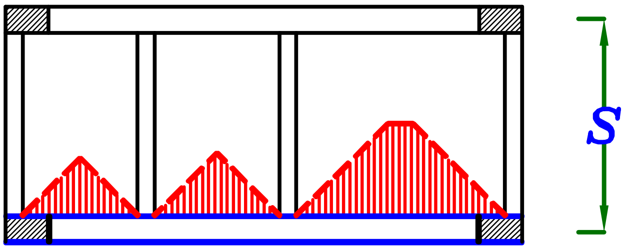
S.F.D.



B.M.D.



ملاحظات هامه

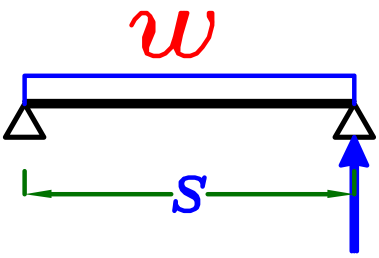


١- اذا كان عدد ال Girders اثنان فقط

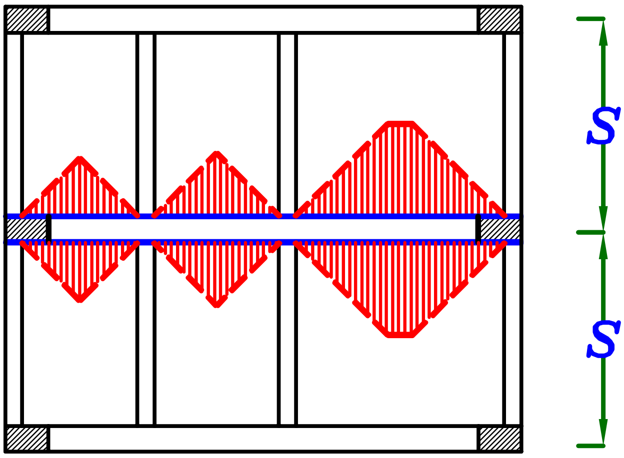
2 Girders only

فتكون الكمره الثانويه كمره Simple Beam

فيكون Reaction الكمرات الثانويه $\boxed{\frac{w * S}{2}}$



$$R = \frac{w * S}{2}$$



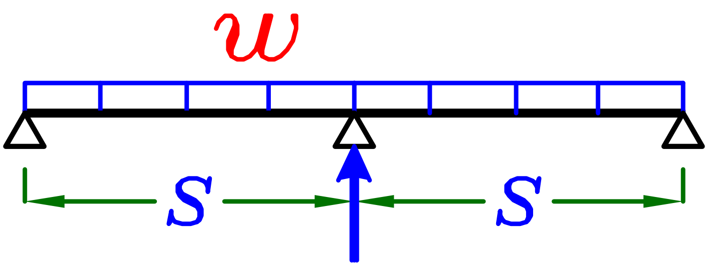
٢- اذا كان عدد ال Girders ثلاثه

و مطلوب الGirder الاوسط

فتكون الكمره الثانويه كمره

Continuous 2 spans.

فيكون Reaction الكمرات الثانويه $\boxed{1.2\, w * S}$



$$R = 1.2\, w * S$$

خطوات مسأله الـ cross-section (max-max)

١- نستنتج الـ *Plan*

٢- نرسم خطوط توزيع الـ *Loads* (*Load Distribution*)

٣- نسمى الكمرات ...... B_1 , B_2 , B_3

٤- نحسب g_s , p_s

٥- نحسب *Load For Shear* للكمرات الثانويه

و نحدد الـ *Reactions* $\boxed{R_T = w * S}$, $\boxed{R_D = g * S}$

٦- نضع الاحمال على الـ *Girder* بالترتيب التالى :-

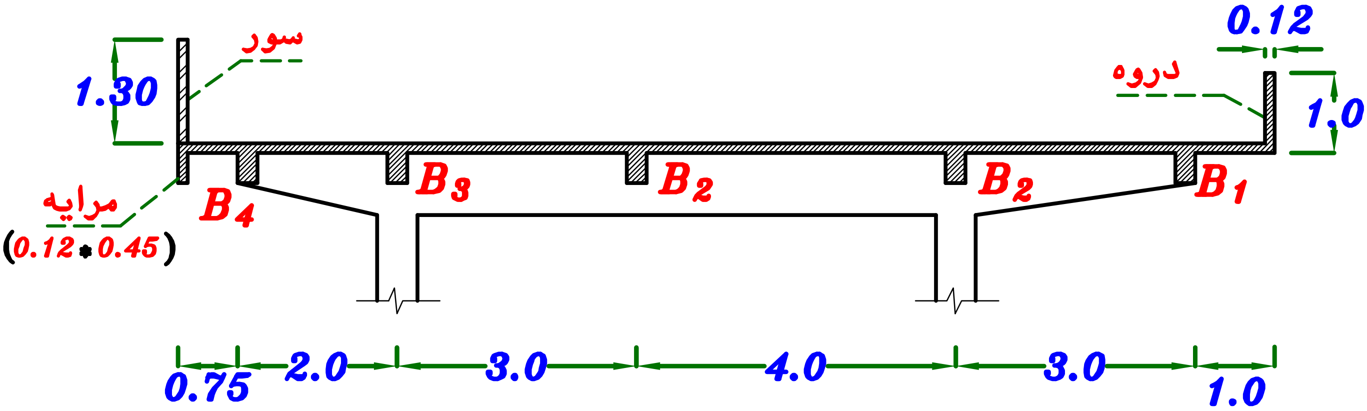
أ - نضع o.w. على الـ *Girder* كله .

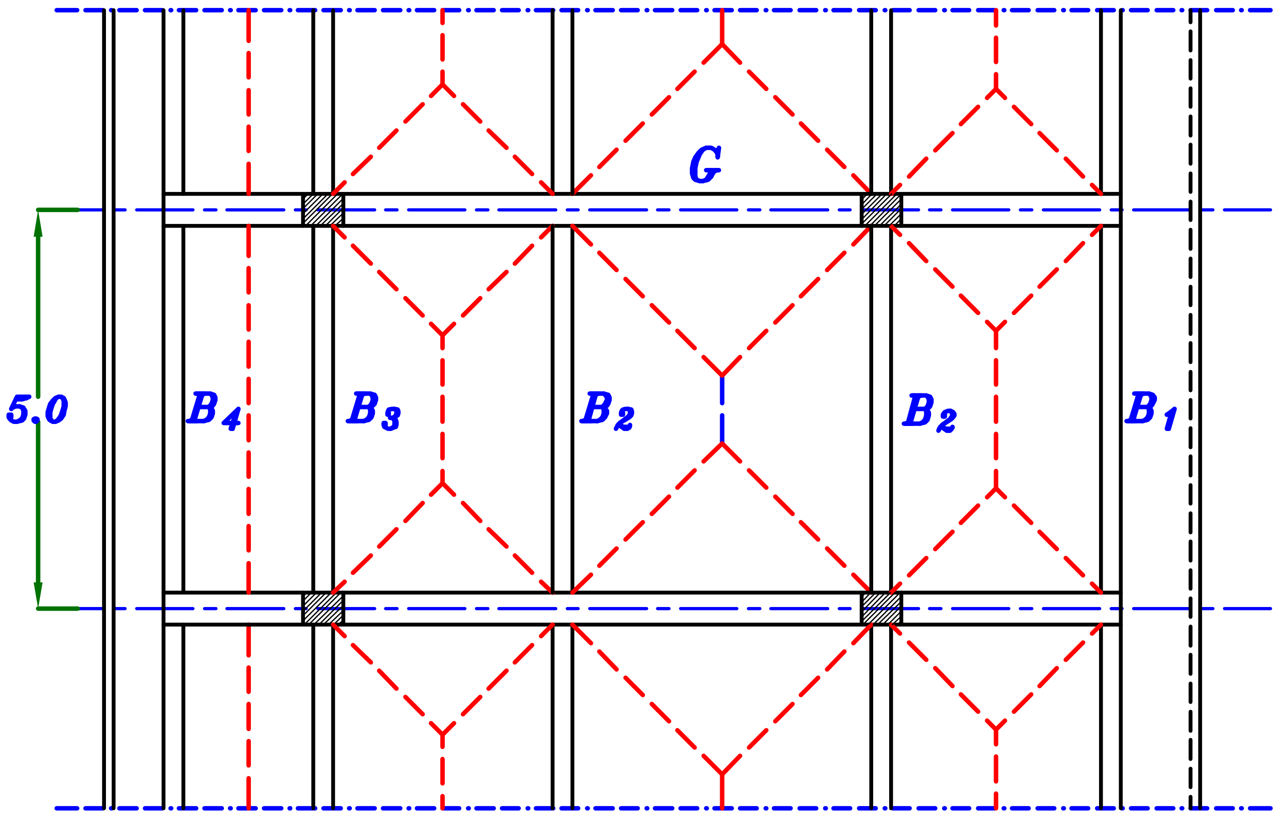
ب - نضع *Reactions* الكمرات الثانويه *concentrated loads* على الـ *Girder*

ج - نضع أحمال البلاطه التى تنتقل مباشره من البلاطه الى الـ *Girder* .
و تظهر هذه الاحمال من الـ *plan*.

٧- نرسم *B.M.D. & S.F.D.* للـ *Girder*

Example.





Data.

$t_s = 0.12$ m F.C. = 1.50 kN\m² L.L. = 2.0 kN\m²

O.W. of Girder = 5.0 kN\m`  O.W. of Beam = 3.0 kN\m`

O.W. Walls = 3.0 kN\m² Spacing = 5.0 m

Req.

1- Draw max.-max. S.F.D. & B.M.D. For B_2

2- Draw S.F.D. & max.-max. B.M.D. For the Girder.
(using woking Loads)

3- Draw max.-max. B.M.D. For the Girder.
(using Ultimate Limits Loads)

g_s , p_s

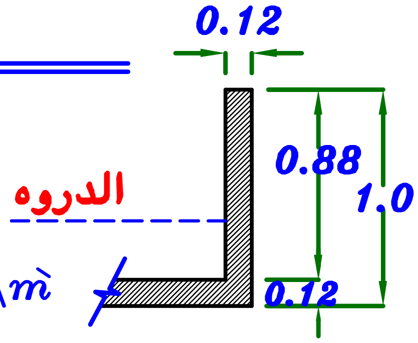
$$D.L. = g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.50 \ kN\backslash m^2$$

$$L.L. = p_s = L.L. = 2.0 \ kN\backslash m^2$$

$$T.L. = w_s = g_s + p_s = 6.50 \ kN\backslash m^2$$

$$\boxed{g_s = 4.50 \ kN\backslash m^2} , \quad \boxed{p_s = 2.0 \ kN\backslash m^2}$$

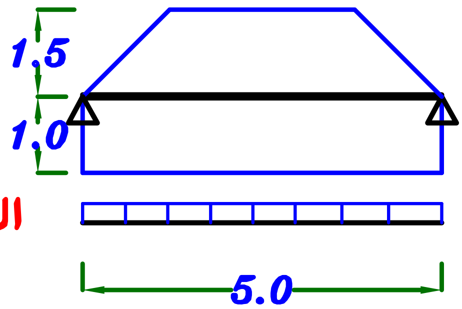
B_1



$O.W.$ (Parapet) (الدروه) $= (0.12)(0.88)(1.0)(25) = 2.64 \ kN\backslash m'$

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3}{5}\right) = 0.70$$



Load For Shear.

$g_a = O.W.$ (الكمره) $+ O.W.$ (الدروه) $+ \overline{g_s L_c} + C_a \, g_s \frac{L_s}{2}$

$$= 3.0 + 2.64 + (4.50)(1.0) + (0.70)(4.50)\left(\frac{3}{2}\right) = 14.865 \ kN\backslash m'$$

$$p_a = p_s L_c + C_a \, p_s \frac{L_s}{2}$$

$$= (2.0)(1.0) + (0.70)(2.0)\left(\frac{3}{2}\right) = 4.10 \ kN\backslash m'$$

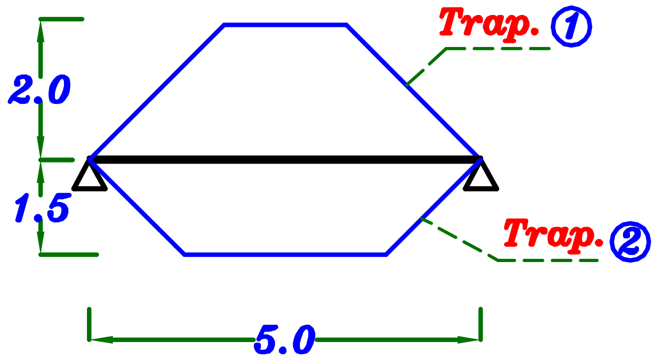
$$w_a = g_a + p_a = 14.865 + 4.10 = 18.965 \ kN\backslash m'$$

$$R_1 = g_a * Spacing = 14.865 * 5.0 = 74.325 \ kN \text{ ---- } D.L.$$

$$= w_a * Spacing = 18.965 * 5.0 = 94.825 \ kN \text{ ---- } T.L.$$

$$\boxed{\begin{aligned} R_1 &= 74.325 \ kN \text{ ---- } D.L. \\ &= 94.825 \ kN \text{ ---- } T.L. \end{aligned}}$$

B_2



For Trapezoid ①

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{5}\right) = 0.60$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4}{5}\right)^2 = 0.786$$

For Trapezoid ②

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3}{5}\right) = 0.70$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3}{5}\right)^2 = 0.88$$

Load For Shear.

$$g_a = O.W. + \underbrace{C_a\, g_s\, \frac{L_s}{2}}_{\text{Trap.①}} + \underbrace{C_a\, g_s\, \frac{L_s}{2}}_{\text{Trap.②}}$$

$$= 3.0 + (0.60)(4.50)\left(\frac{4}{2}\right) + (0.70)(4.50)\left(\frac{3}{2}\right) = 13.125 \ kN\backslash m`$$

$$p_a = \underbrace{C_a\, p_s\, \frac{L_s}{2}}_{\text{Trap.①}} + \underbrace{C_a\, p_s\, \frac{L_s}{2}}_{\text{Trap.②}}$$

$$= (0.60)(2.0)\left(\frac{4}{2}\right) + (0.70)(2.0)\left(\frac{3}{2}\right) = 4.50 \ kN\backslash m`$$

$$w_a = g_a + p_a = 13.125 + 4.50 = 17.625 \ kN\backslash m`$$

Load For Moment.

$$g_e = O.W. + \underbrace{C_e\, g_s\, \frac{L_s}{2}}_{\text{Trap.①}} + \underbrace{C_e\, g_s\, \frac{L_s}{2}}_{\text{Trap.②}}$$

$$= 3.0 + (0.786)(4.50)\left(\frac{4}{2}\right) + (0.88)(4.50)\left(\frac{3}{2}\right) = 16.014 \ kN\backslash m`$$

$$p_e = \underbrace{C_e\, p_s\, \frac{L_s}{2}}_{\text{Trap.①}} + \underbrace{C_e\, p_s\, \frac{L_s}{2}}_{\text{Trap.②}}$$

$$= (0.786)(2.0)\left(\frac{4}{2}\right) + (0.88)(2.0)\left(\frac{3}{2}\right) = 5.784 \ kN\backslash m`$$

$$w_e = g_e + p_e = 16.014 + 5.784 = 21.80 \ kN\backslash m`$$

$$R_2 = g_a * Spacing = 13.125 * 5.0 = 65.625 \ kN \text{ ------ D.L.}$$

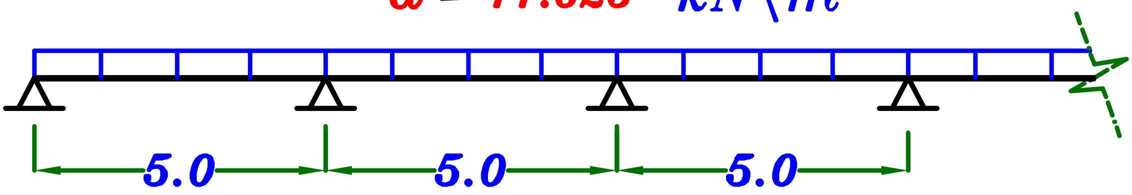
$$= w_a * Spacing = 17.625 * 5.0 = 88.125 \ kN \text{ ------ T.L.}$$

$$\boxed{\begin{aligned} R_2 &= 65.625 \ kN \text{ ---- D.L.} \\ &= 88.125 \ kN \text{ ---- T.L.} \end{aligned}}$$

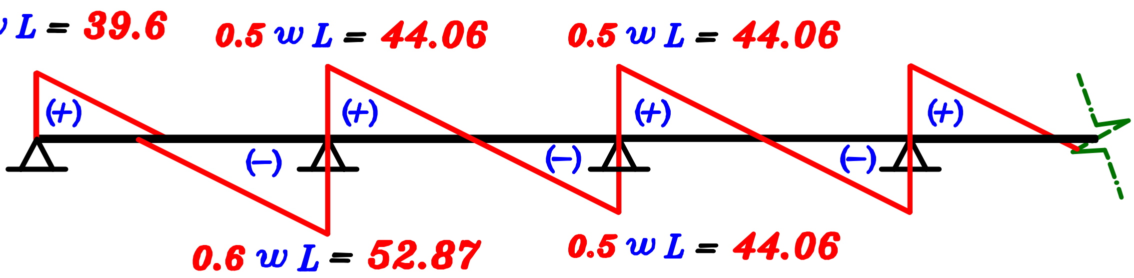
max–max S.F.D. For B_2

Load For Shear

$w_a = 17.625 \ kN \backslash m'$



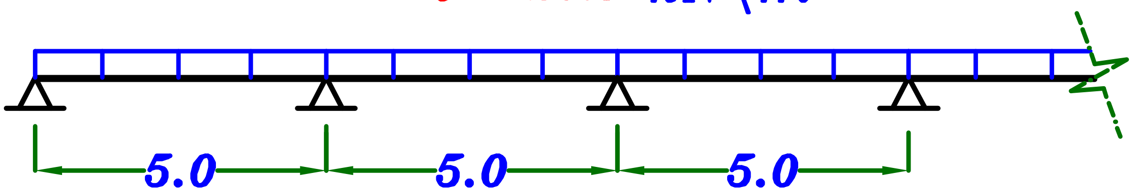
S.F.D.



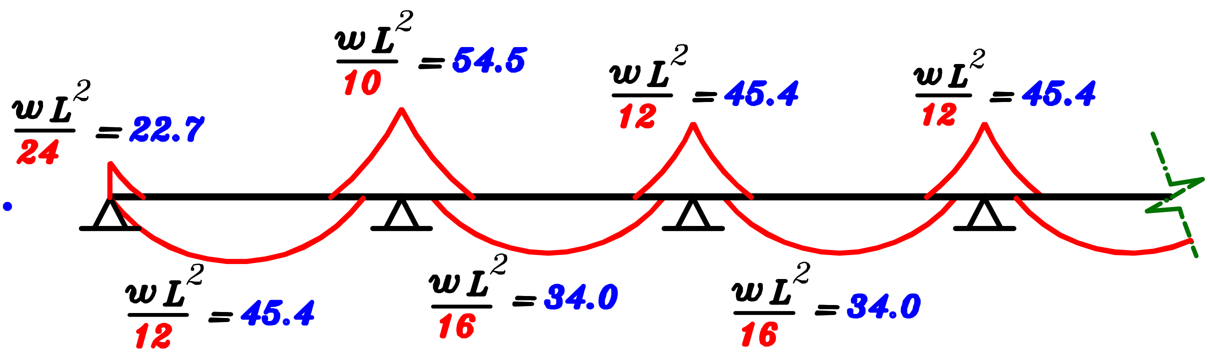
max–max B.M.D. For B_2

Load For Moment.

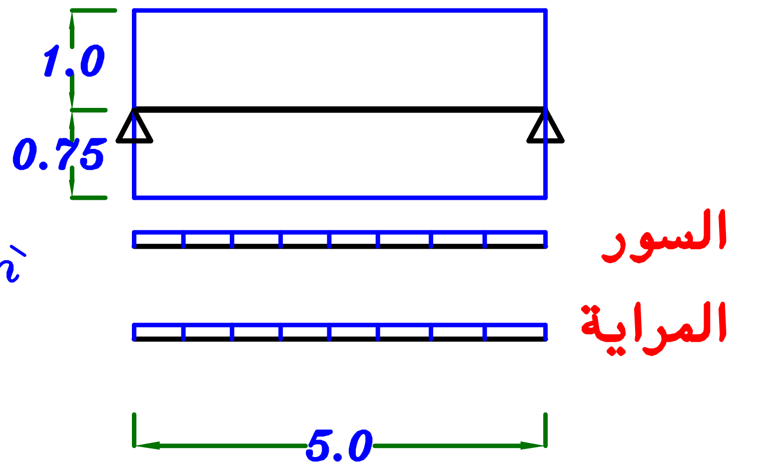
$w_e = 21.8 \ kN \backslash m'$



B.M.D.



B_4



O.W. (السور) $= h_w * \gamma_w$

$= (1.3)(3.0) =$ **3.90** kN\m`

O.W. (المراية) $= b \; t \; \gamma_c$

$= (0.12)(0.45)(25) =$ **1.35** kN\m`

Load For Shear.

$g_a =$ O.W. (الكمره) + O.W. (المراية) + O.W. (السور) $+ \overline{g_s} \, L_c + \overline{g_s} \, \frac{L_s}{2}$

$= 3.0 + 1.35 + 3.90 + (4.50)(0.75) + (4.50)(\frac{2}{2}) =$ **16.125** kN\m`

$p_a = \overline{p_s} \, L_c + \overline{p_s} \, \frac{L_s}{2}$

$= (2.0)(0.75) + (2.0)(\frac{2}{2}) =$ **3.50** kN\m`

$w_a = g_a + p_a = 16.125 + 3.50 =$ **19.625** kN\m`

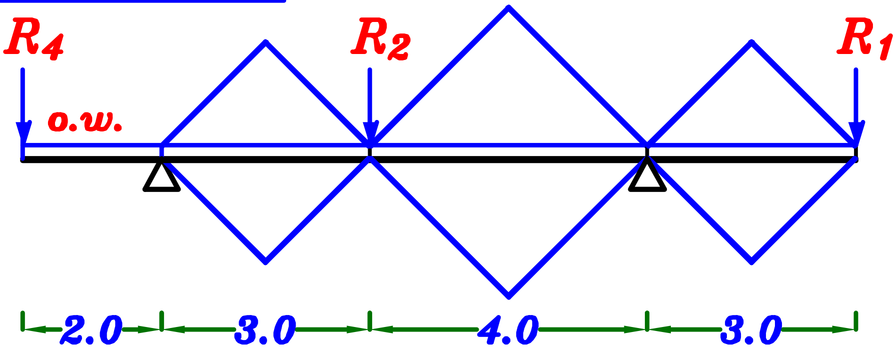
$R_4 = g_a *$ Spacing $= 16.125 * 5.0 =$ **80.625** kN ---- D.L.

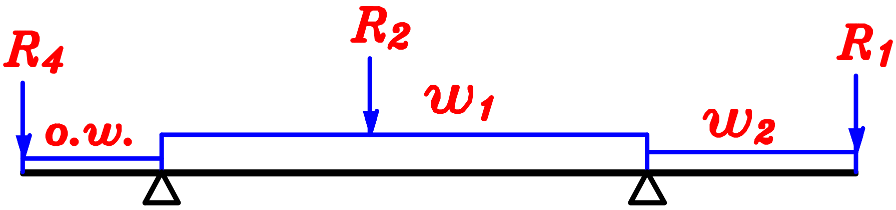
$= w_a *$ Spacing $= 19.625 * 5.0 =$ **98.125** kN ---- T.L.

$R_4 =$ **80.625 kN** ---- D.L.

$=$ **98.125 kN** ---- T.L.

Loads on the girder.





Loads on the mid. Span. (w_1)

$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(3)(1.5)\right) + 2\left(\frac{1}{2}(4)(2)\right)}{7.0} = 1.785$$

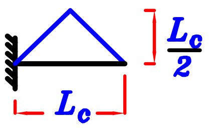
$$g_1 = g_a = g_e = o.w. + \frac{\sum area}{span} * g_s = 5.0 + 1.785\ (4.50) = 13.03\ kN \backslash m'$$

$$p_1 = p_a = p_e = \frac{\sum area}{span} * p_s = 1.785\ (2.0) = 3.57\ kN \backslash m'$$

$$w_1 = w_a = w_e = g_1 + p_1 = 13.03 + 3.57 = 16.60\ kN \backslash m'$$

$$\boxed{\begin{array}{l} g_1 = 13.03\ kN \backslash m' \text{ --- D.L.} \\ w_1 = 16.60\ kN \backslash m' \text{ --- T.L.} \end{array}}$$

Loads on the right Cantilever. (w_2)



$C_a = C_e = \frac{1}{2}$ **Load For Shear = Load For Moment**

$$g_2 = o.w. + 2\left[C_a\ g_s\ \frac{L_c}{2}\right] = 5.0 + 2\left[\left(\frac{1}{2}\right)(4.50)\left(\frac{3}{2}\right)\right] = 11.75\ kN \backslash m'$$

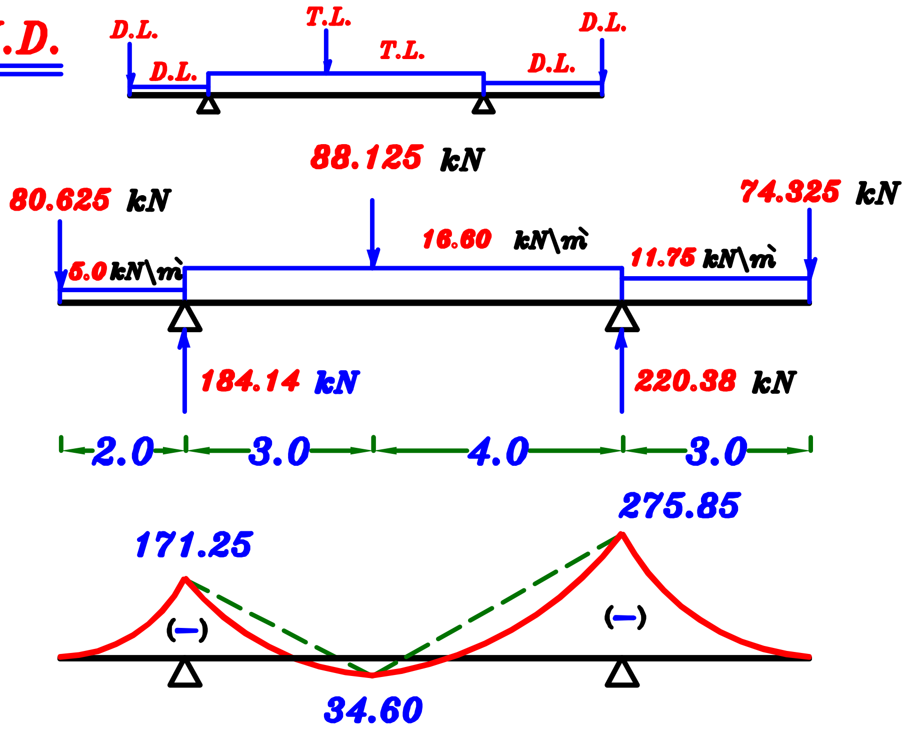
$$p_2 = 2\left[C_a\ p_s\ \frac{L_c}{2}\right] = 2\left[\left(\frac{1}{2}\right)(2.0)\left(\frac{3}{2}\right)\right] = 3.0\ kN \backslash m'$$

$$w_2 = g_2 + p_2 = 11.75 + 3.0 = 14.75\ kN \backslash m'$$

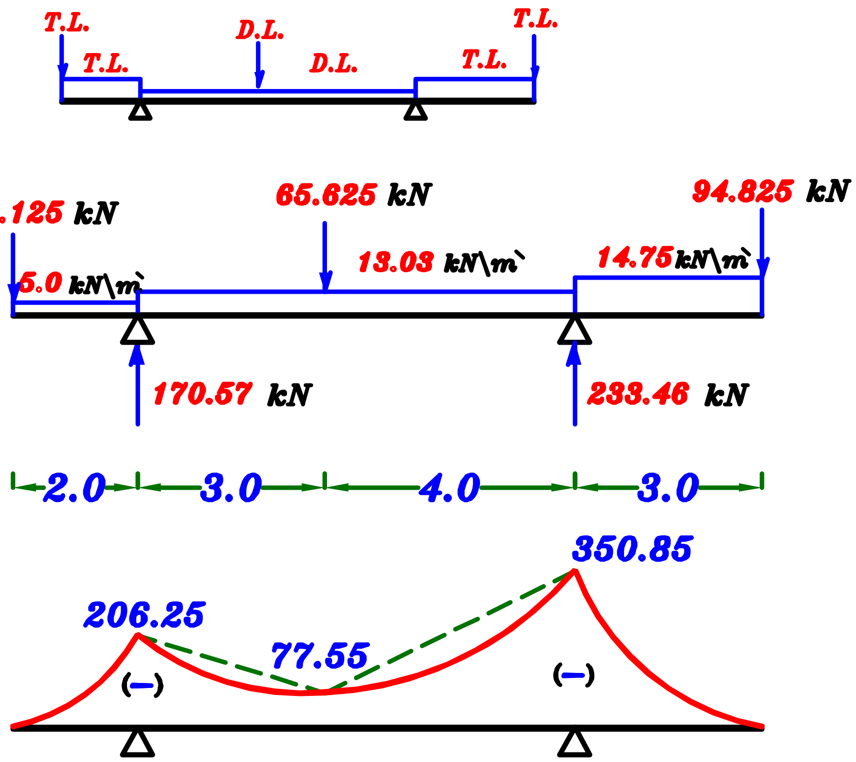
$$\boxed{\begin{array}{l} g_2 = 11.75\ kN \backslash m' \text{ --- D.L.} \\ w_2 = 14.75\ kN \backslash m' \text{ --- T.L.} \end{array}}$$

max–max B.M.D. For the Girder. (using woking Loads)

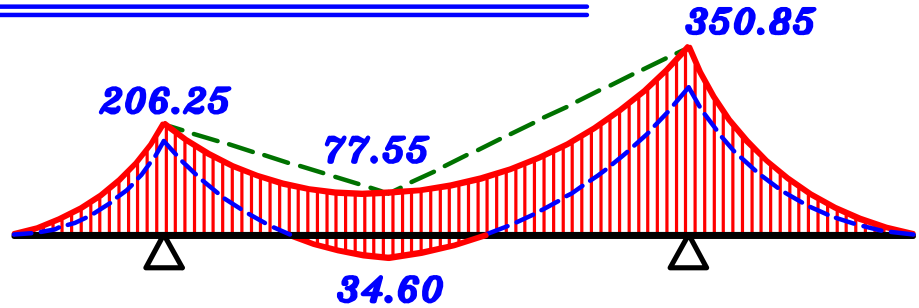
1- max. +ve B.M.D.



2- max. –ve B.M.D.

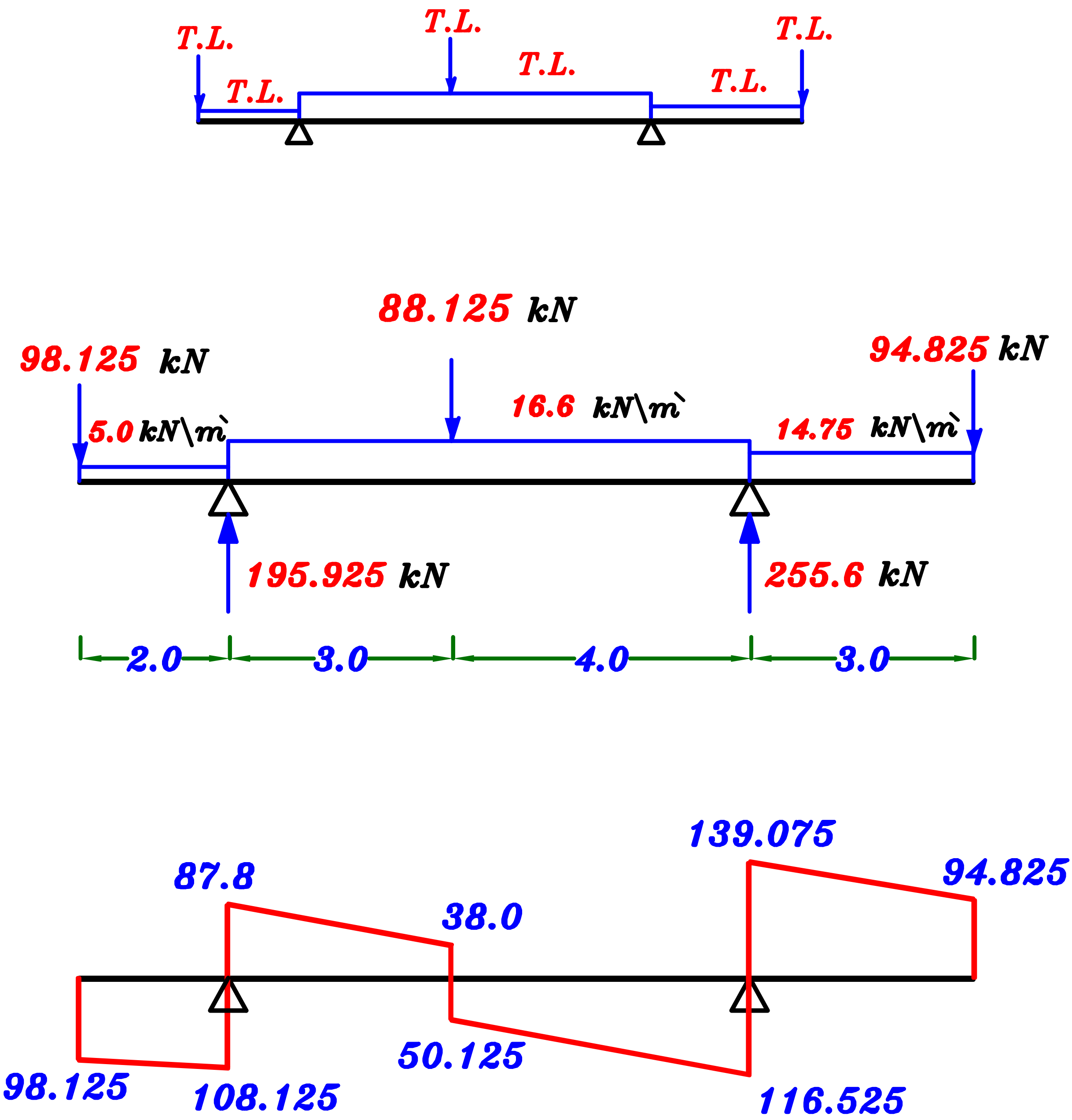


max–max B.M.D. For the Girder.



S.F.D. For the Girder.

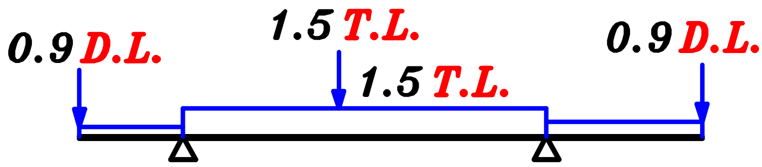
Take Total Load on all the spans.

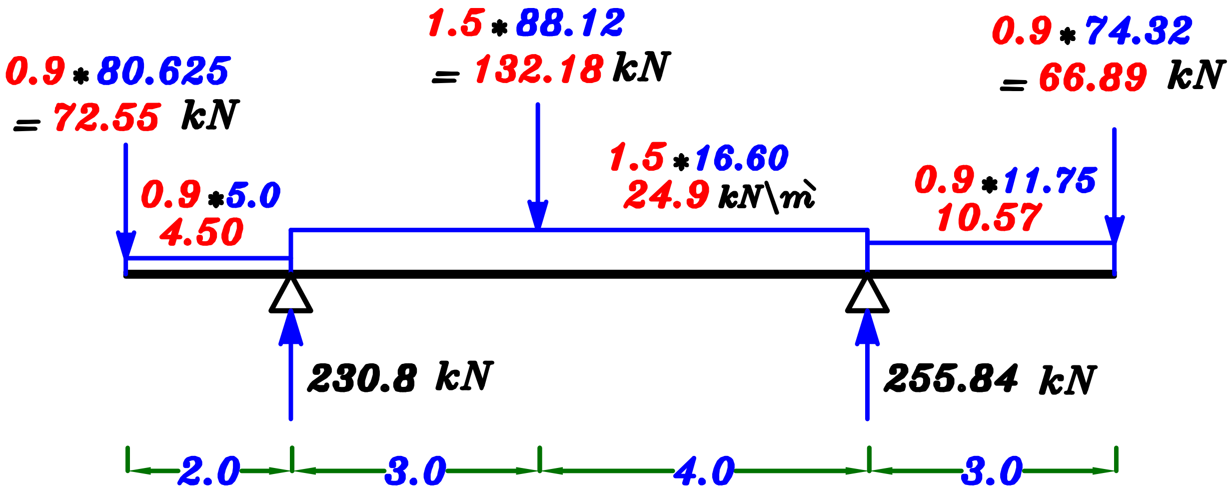


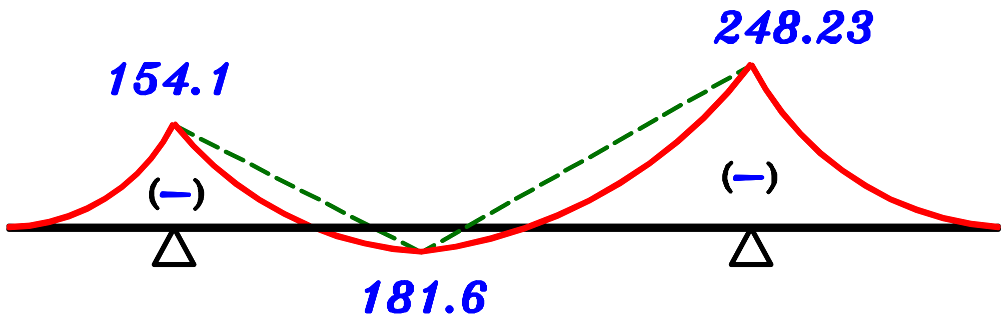
max–max B.M.D. For the Girder.

(using Ultimate Limits Loads)

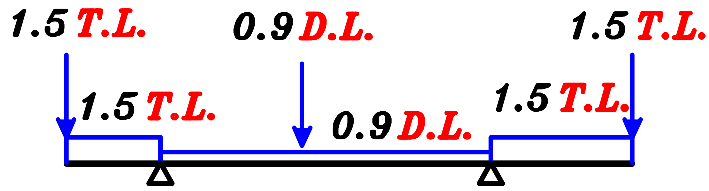
1- max. +Ve B.M.D.

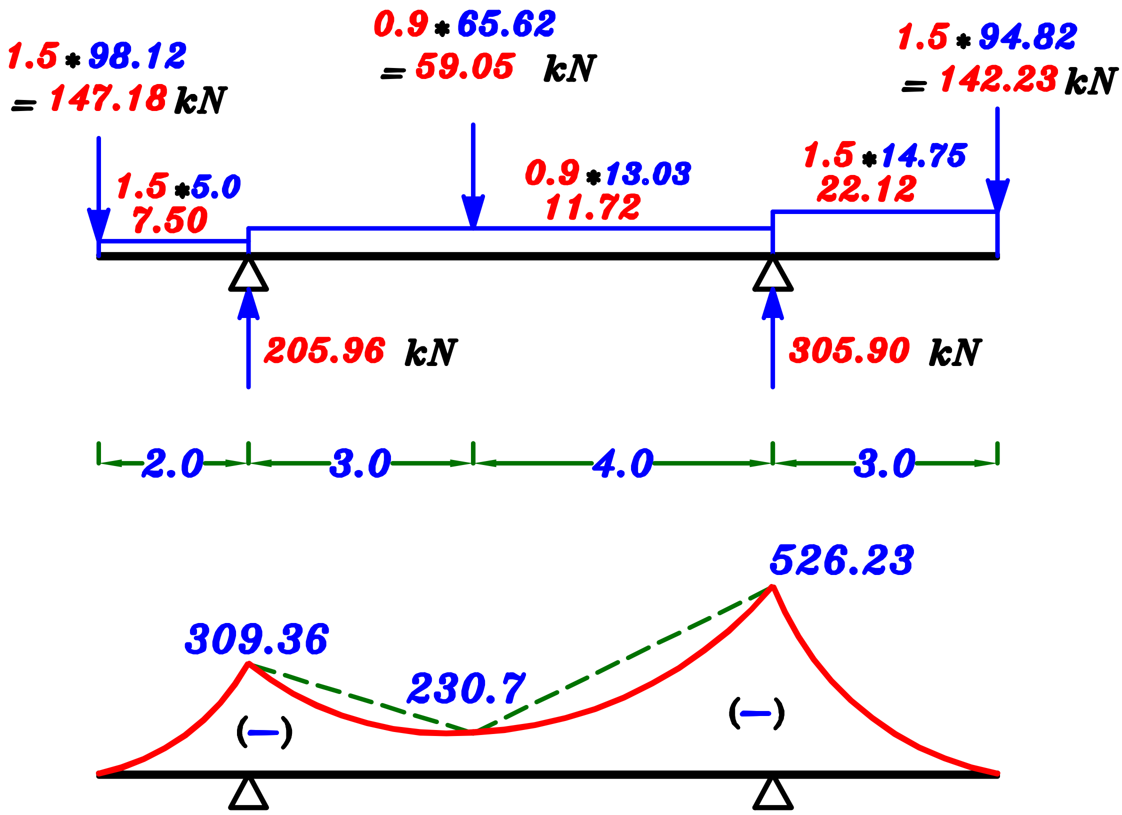






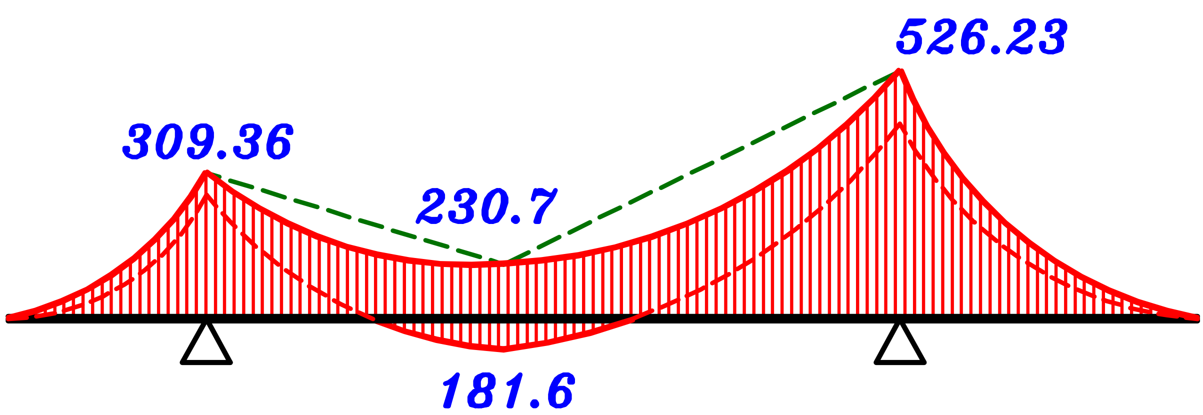
2- max. -Ve B.M.D.



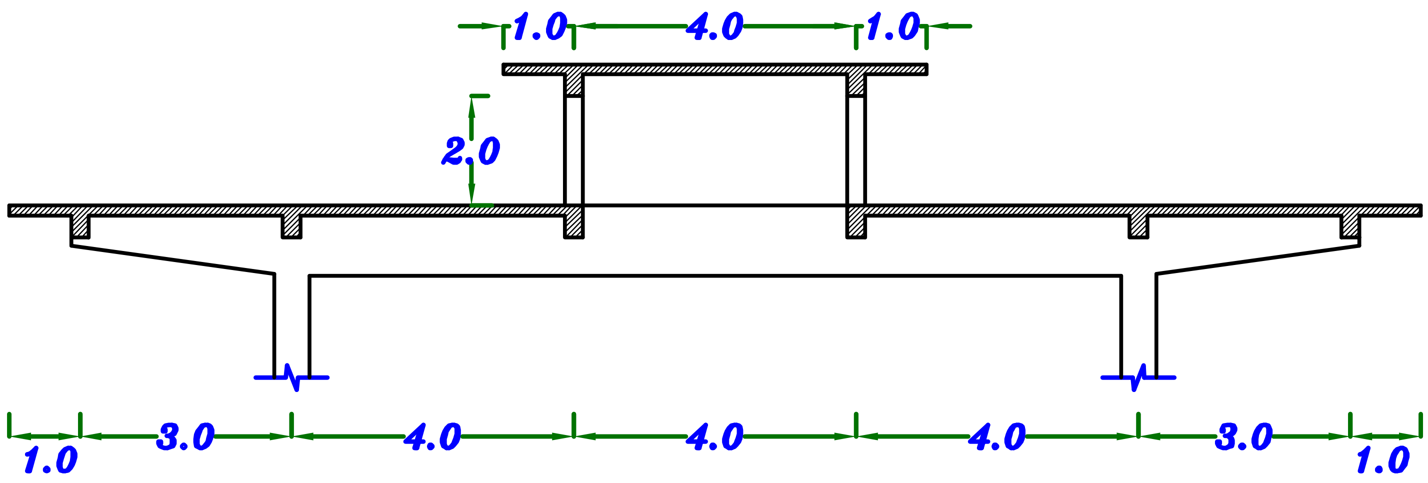


max-max B.M.D. For the Girder.

(using Ultimate Limits Loads)



Example.



a- Draw structural plan showing the pattern of load distribution.

b- Calculate the equivalent working loads For shear and moment For an interior girder (G).

c- Draw the maximum-maximum bending moment on the girder (G). (using working loads).

d- Draw the maximum-maximum bending moment on the girder (G). (using ultimat limits loads).

e- Draw the shearing Force diagram For the girder (G) For the case of the total load only. (using working loads).

Data :

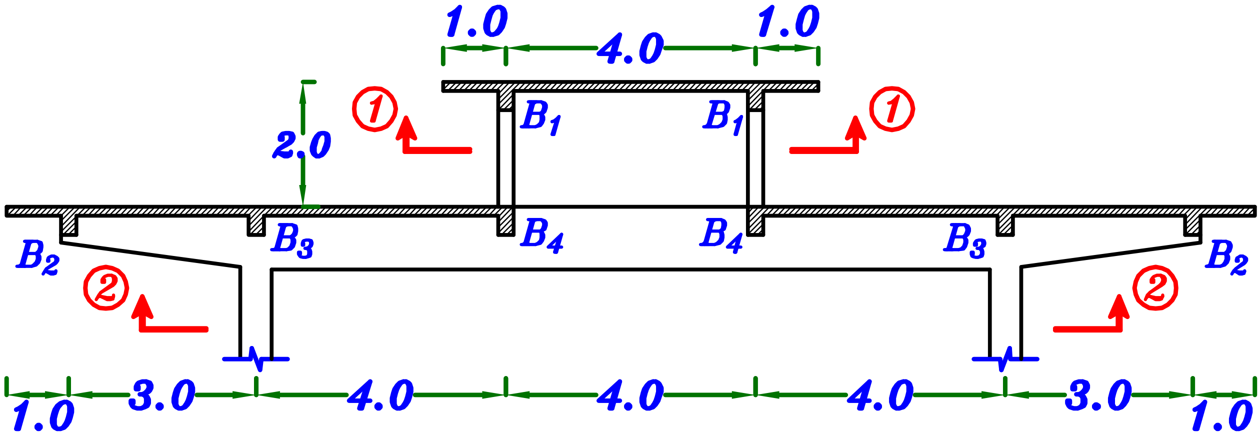
$t_s = 0.12\ m$, Spacing $= 5.0\ m$

F.C. $= 1.0\ kN\backslash m^2$, L.L. $= 1.0\ kN\backslash m^2$

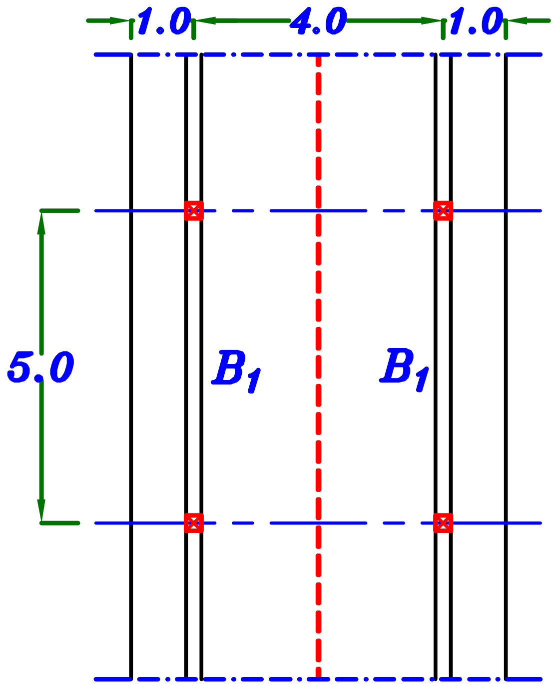
o.w. (beams) $= 3.0\ kN\backslash m'$, o.w. (girder) $= 6.0\ kN\backslash m'$

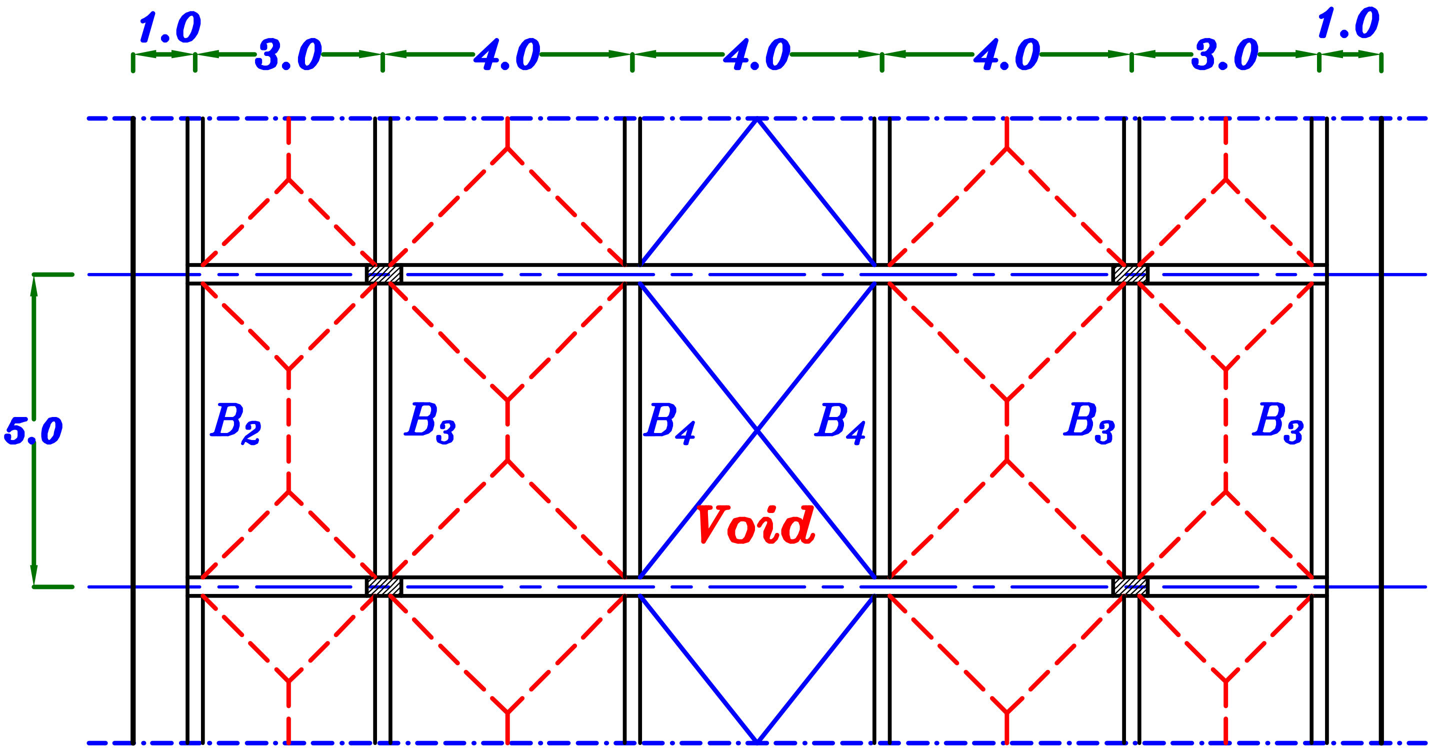
b (beams) $= 250\ mm$, b (girder) $= 300\ mm$

1_ Structural plans.



Plan ①





Plan ②

g_s , p_s

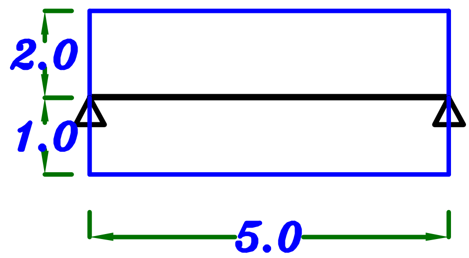
$$D.L. = g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.0 = 4.0 \ kN\backslash m^2$$

$$L.L. = p_s = L.L. = 1.0 \ kN\backslash m^2$$

$$T.L. = w_s = g_s + p_s = 5.0 \ kN\backslash m^2$$

$\boxed{g_s = 4.0 \ kN\backslash m^2}$, $\boxed{p_s = 1.0 \ kN\backslash m^2}$

B_1 Load For Shear.



$$g_a = O.W. + g_s L_c + g_s \frac{L_s}{2}$$

$$= 3.0 + (4.0)(1.0) + (4.0)\left(\frac{4}{2}\right) = 15.0 \ kN\backslash m'$$

$$p_a = p_s L_c + p_s \frac{L_s}{2} = (1.0)(1.0) + (1.0)\left(\frac{4}{2}\right) = 3.0 \ kN\backslash m'$$

$$w_a = g_a + p_a = 15.0 + 3.0 = 18.0 \ kN\backslash m'$$

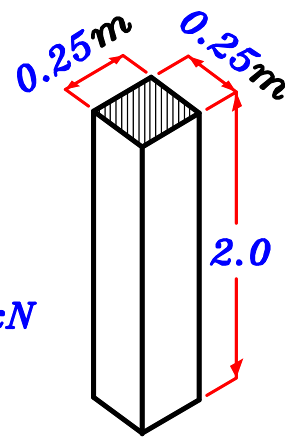
$R_1 = g_a * Spacing = 15.0 * 5.0 = 75.0 \ kN$ ----- D.L.

$= w_a * Spacing = 18.0 * 5.0 = 90.0 \ kN$ ----- T.L.

$R_1 = 75.0 \ kN$ ---- D.L.

$= 90.0 \ kN$ ---- T.L.

Post

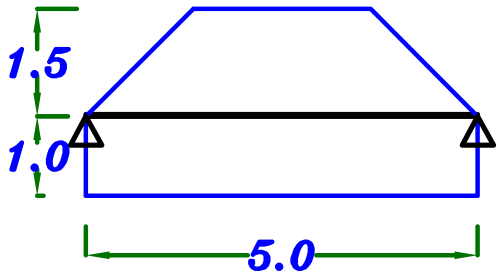


Weight of the Post = Volume * Density

$= (0.25 * 0.25 * 2.0)(25) = 3.1 \ kN$

Weight of the Post = 3.1 kN

B_2



For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3}{5}\right) = 0.70$$

Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + g_s L_c = 3.0 + (0.70)(4.0)\left(\frac{3}{2}\right) + (4.0)(1.0) = 11.2 \ kN/m'$$

$$p_a = C_a\, p_s \frac{L_s}{2} + p_s L_c = (0.70)(1.0)\left(\frac{3}{2}\right) + (1.0)(1.0) = 2.05 \ kN/m'$$

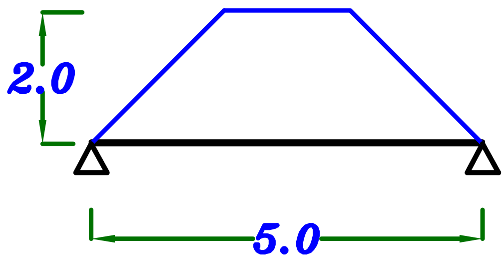
$$w_a = g_a + p_a = 11.2 + 2.05 = 13.25 \ kN/m'$$

$$R_2 = g_a * Spacing = 11.2 * 5.0 = 56.0 \ kN \text{ ----- } D.L.$$

$$= w_a * Spacing = 13.25 * 5.0 = 66.25 \ kN \text{ ----- } T.L.$$

$$\boxed{\begin{aligned} R_2 &= 56.0 \ kN \text{ ---- } D.L. \\ &= 66.25 \ kN \text{ ---- } T.L. \end{aligned}}$$

B_4



For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{5}\right) = 0.60$$

Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} = 3.0 + (0.60)(4.0)\left(\frac{4}{2}\right) = 7.8 \ kN/m'$$

$$p_a = C_a\, p_s \frac{L_s}{2} = (0.60)(1.0)\left(\frac{4}{2}\right) = 1.2 \ kN/m'$$

$$w_a = g_a + p_a = 7.80 + 1.20 = 9.0 \ kN/m'$$

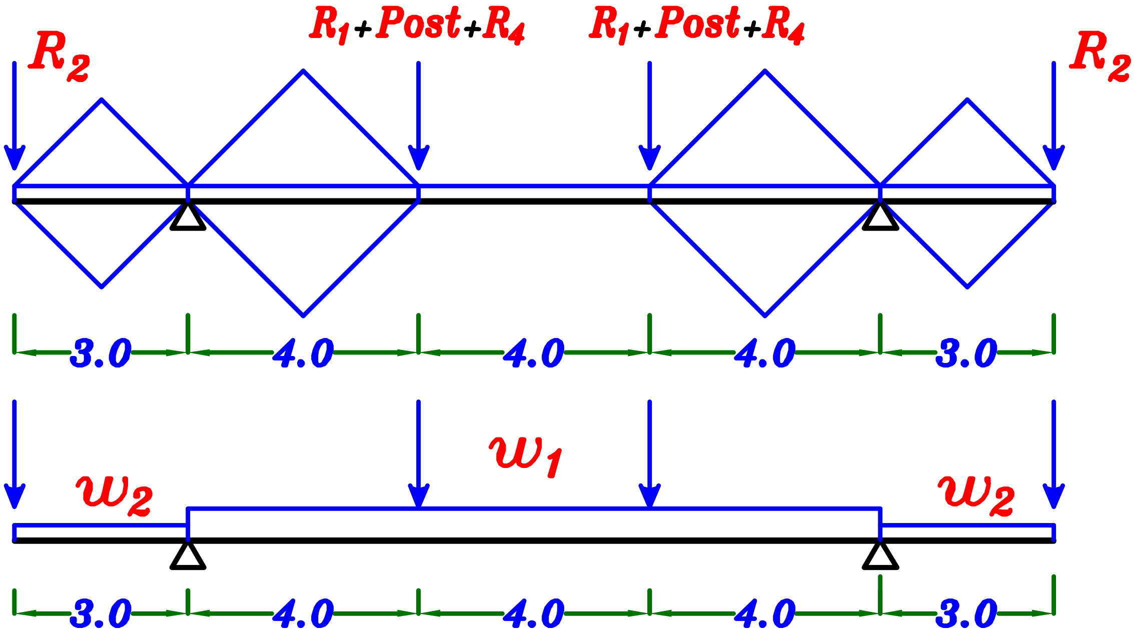
$$R_4 = g_a * Spacing = 7.8 * 5.0 = 39.0 \ kN \text{ ----- } D.L.$$

$$= w_a * Spacing = 9.0 * 5.0 = 45.0 \ kN \text{ ----- } T.L.$$

$$\boxed{\begin{aligned} R_4 &= 39.0 \ kN \text{ ----- } D.L. \\ &= 45.0 \ kN \text{ ----- } T.L. \end{aligned}}$$

G

Load on Girder.



w_1

Load For shear = Load For Moment

$$\frac{\sum area}{span} = \frac{4\left(\frac{1}{2}\right)(4.0)(2.0)}{12.0} = \frac{4}{3}$$

$$g_1 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + \left(\frac{4}{3}\right)(4.0) = 11.33 \ kN\backslash m`$$

$$p_1 = \frac{\sum area}{span} * p_s = \left(\frac{4}{3}\right)(1.0) = 1.33 \ kN\backslash m`$$

$$w_1 = g_1 + p_1 = 11.33 + 1.33 = 12.66 \ kN\backslash m`$$

$$\boxed{\begin{array}{l} g_1 = 11.33 \ kN\backslash m` \text{ --- D.L.} \\ w_1 = 12.66 \ kN\backslash m` \text{ --- T.L.} \end{array}}$$

w_2

For triangle $C_a = C_e = \frac{1}{2}$

$$g_a = g_e = o.w. + 2\, C_a\, g_s \frac{L_c}{2} = 6.0 + 2\left(\frac{1}{2}\right)(4.0)\left(\frac{3.0}{2}\right) = 12.0 \ kN\backslash m`$$

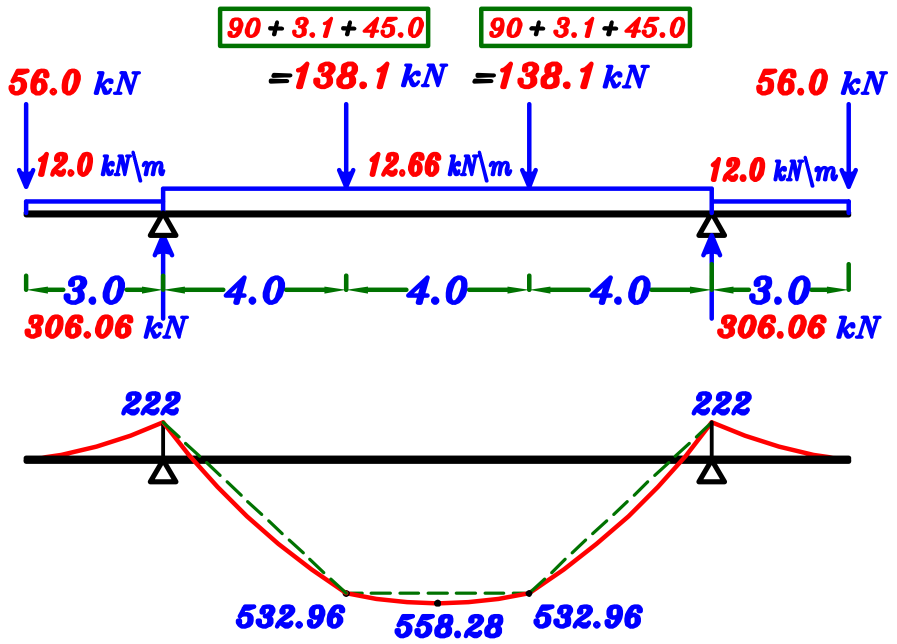
$$p_a = p_e = 2\, C_a\, p_s \frac{L_c}{2} = 2\left(\frac{1}{2}\right)(1.0)\left(\frac{3.0}{2}\right) = 1.50 \ kN\backslash m`$$

$$w_a = w_e = g_a + p_a = 12.0 + 1.50 = 13.5 \ kN\backslash m`$$

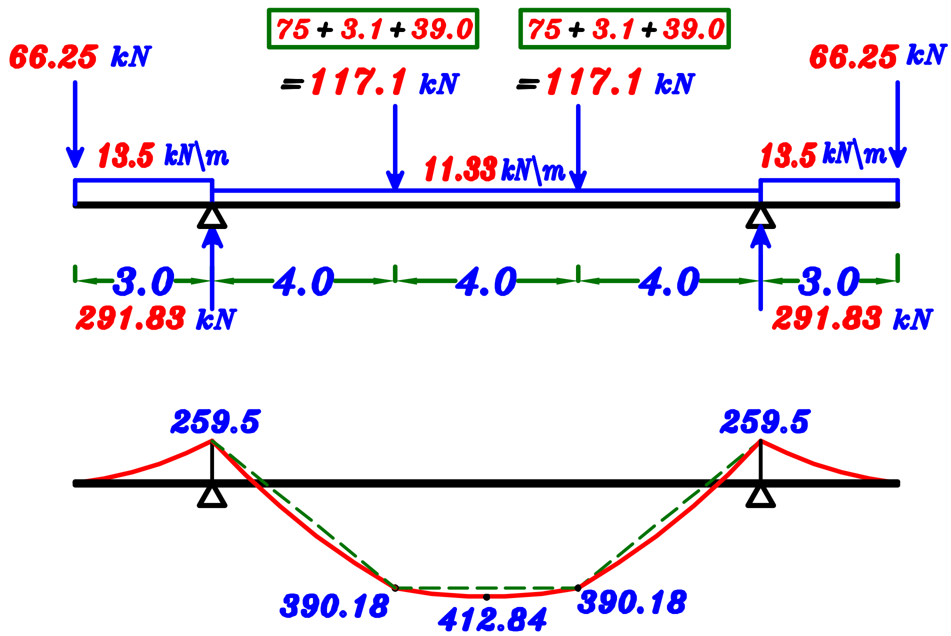
$$\boxed{\begin{array}{l} g_2 = 12.0 \ kN\backslash m` \text{ --- D.L.} \\ w_2 = 13.5 \ kN\backslash m` \text{ --- T.L.} \end{array}}$$

max-max B.M.D. on Girder (G) (using working loads)

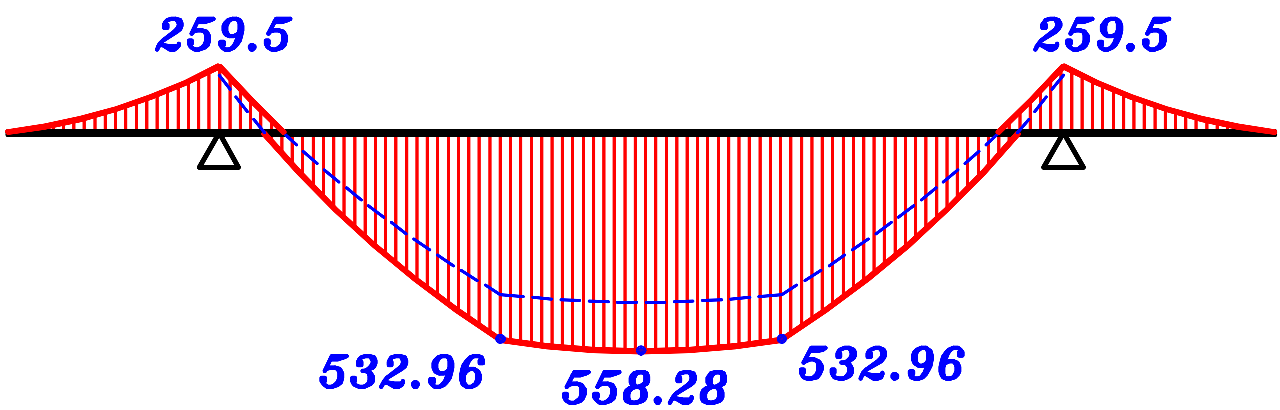
1- max. +ve B.M.D.



2- max. -ve B.M.D.

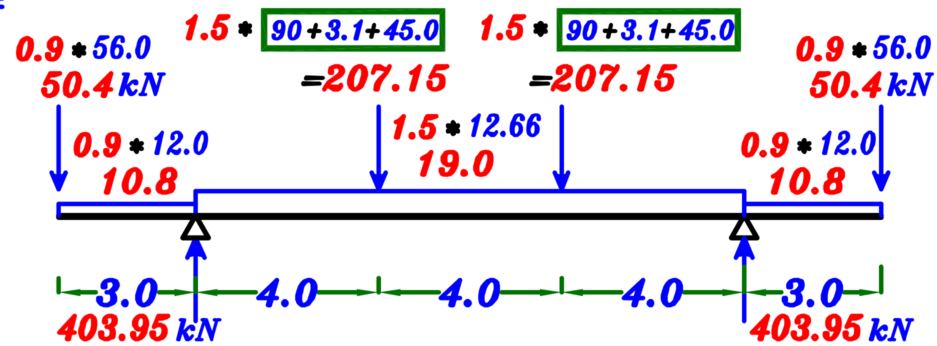


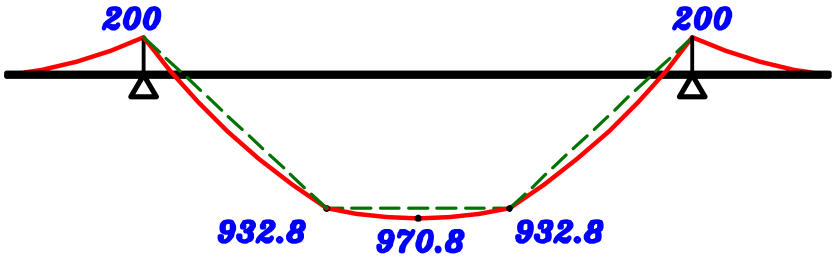
max-max B.M.D. For the Girder.



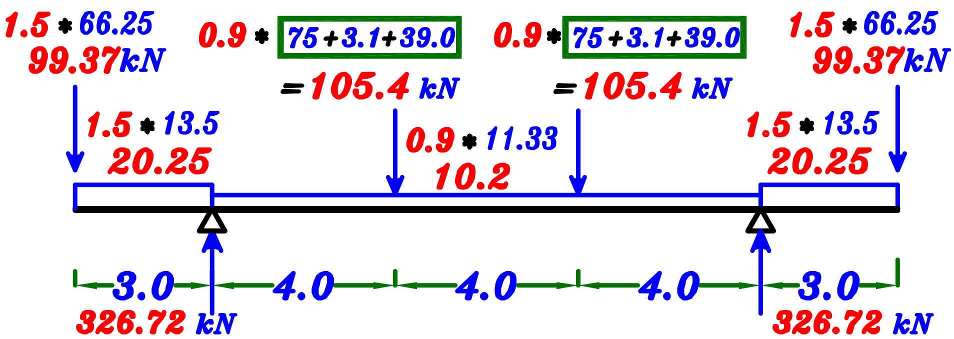
max–max B.M.D. on Girder (G) (using ultimate limits loads)

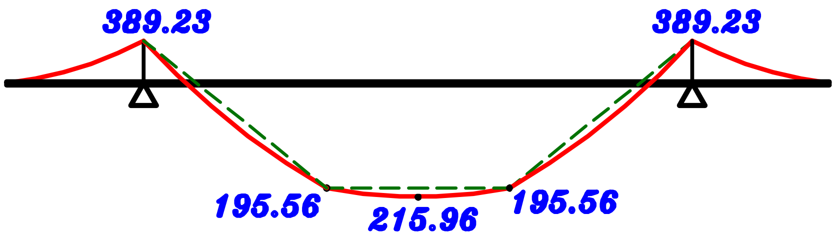
1– max. +ve B.M.D.



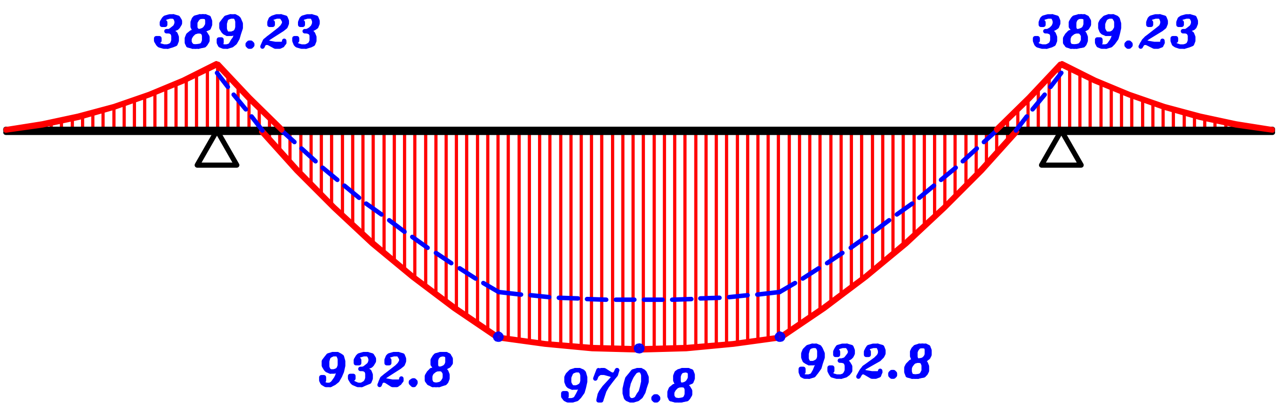


2 – max. –ve B.M.D.

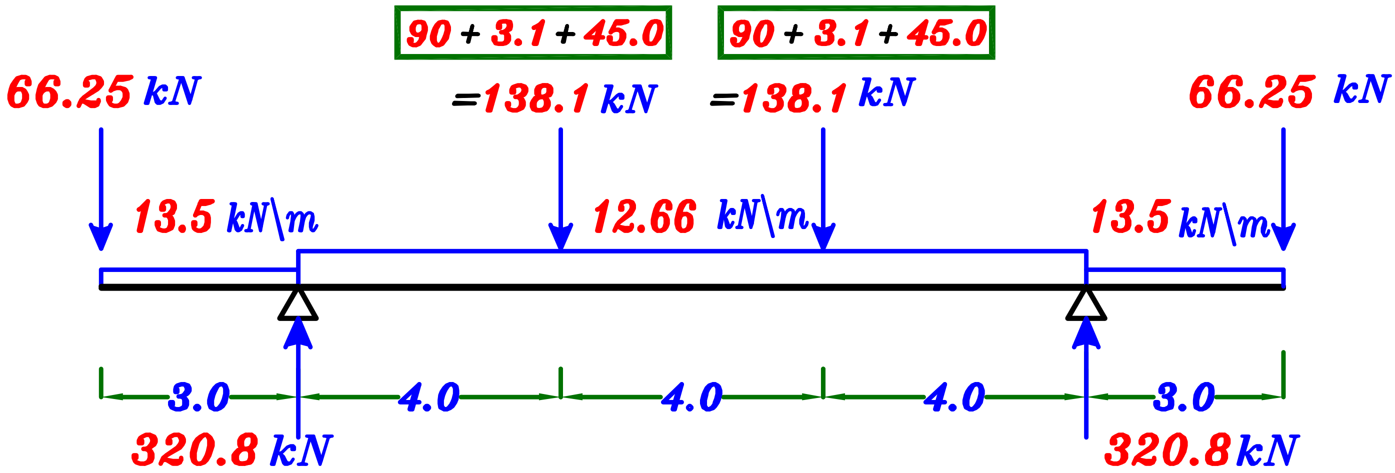


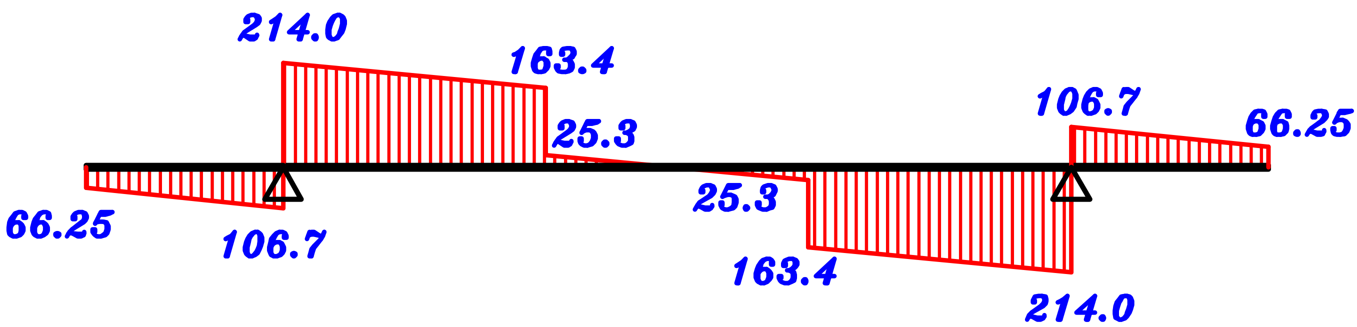


max–max B.M.D. For the Girder.



S.F.D. For the Girder (G) (using working loads)



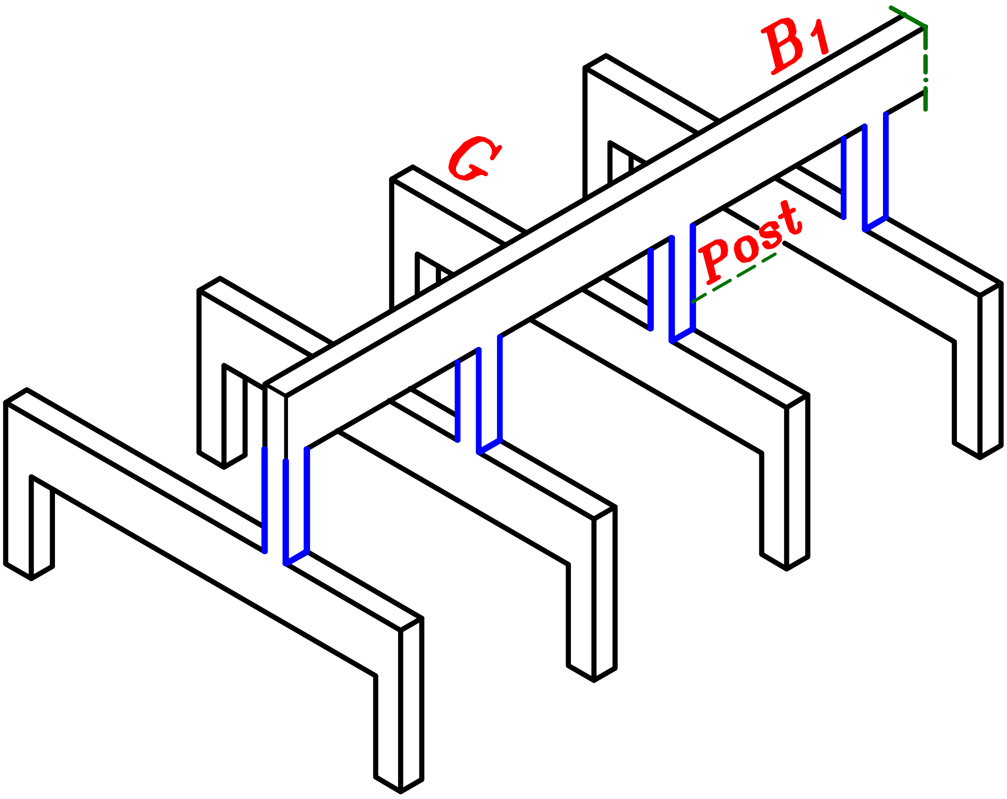


Post (شمعه)

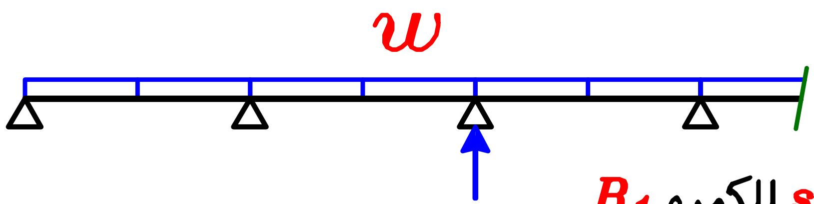
هو عنصر يربط بين عنصرين يحمل احداهما و محمول على الاخر

اى انه ينقل الوزن من العنصر المحمول الى العنصر الذى يحمله

و يكون دائما عليه ضغط. (Compression)



B_1



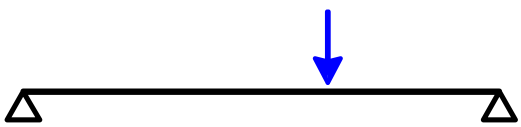
ال post يعتبر support للكمره B_1

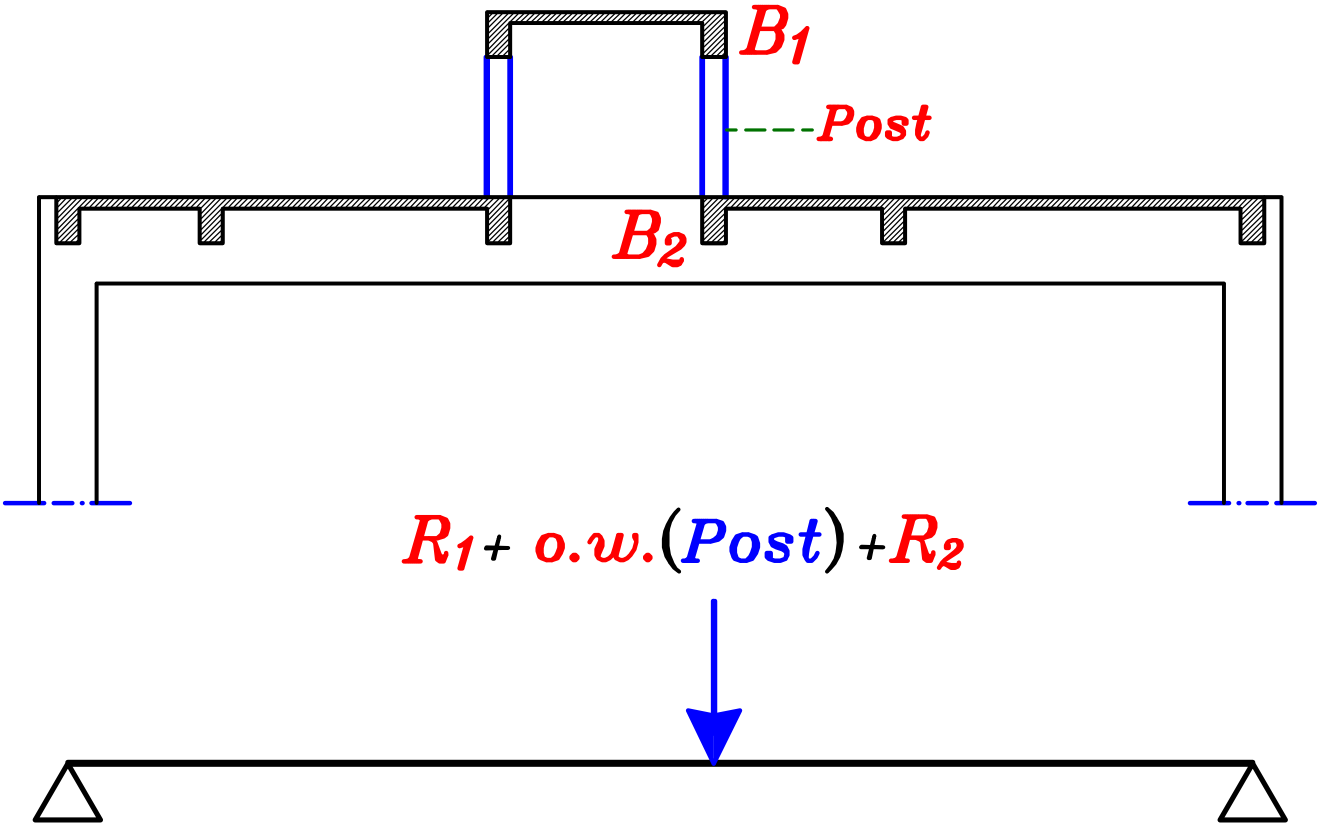
Post

Compression

ال post يعتبر Load للكمره G

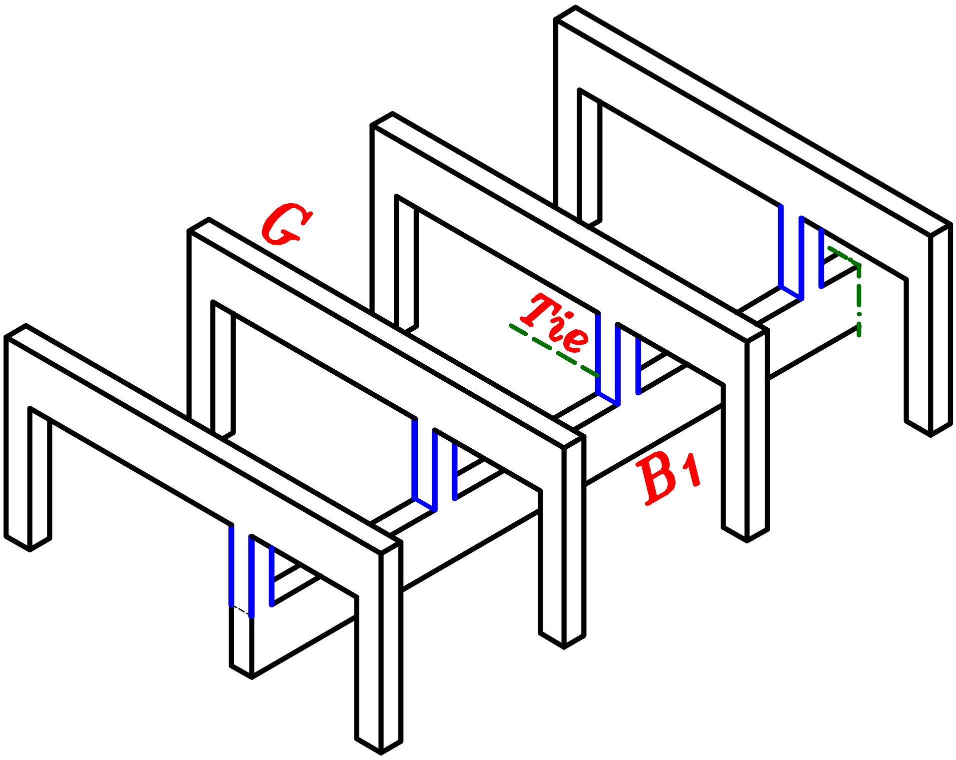
G




B1
Post
B2
R1 + o.w.(Post) + R2

Tie (Hanger) (شداد)

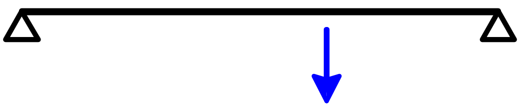
هو عنصر يربط بين عنصرين يحمل احداهما و محمول على الاخر
اى انه ينقل الوزن من العنصر المحمول الى العنصر الذى يحمله
و يكون دائما عليه شد . (Tension)



الكمره B_1 محموله على ال Tie و ال Tie محمول على ال Girder

G

ال Tie تعتبر Load للكمره G

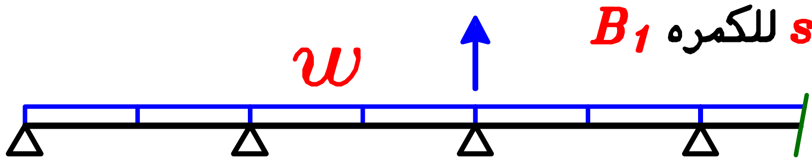


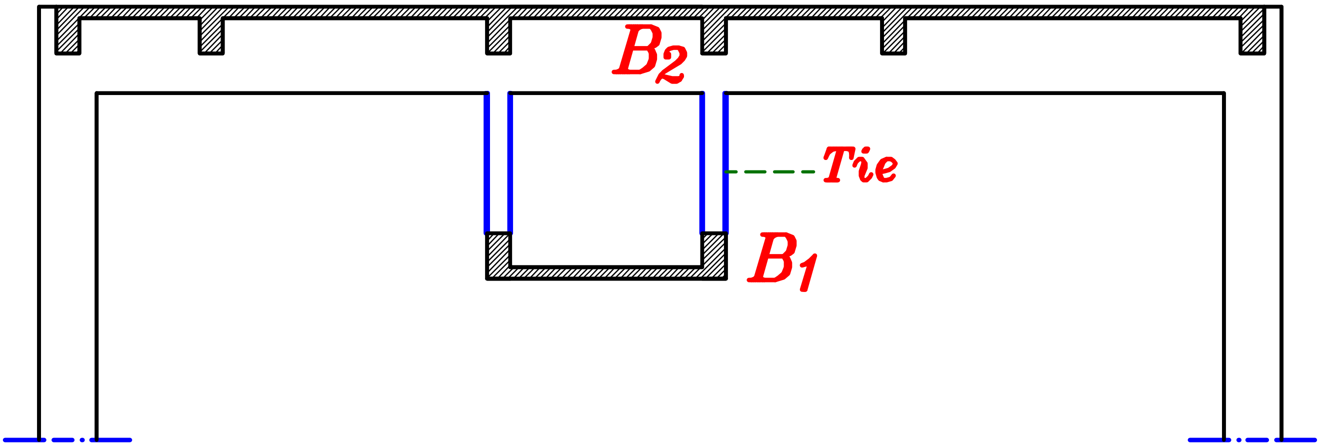
Tie

Tension

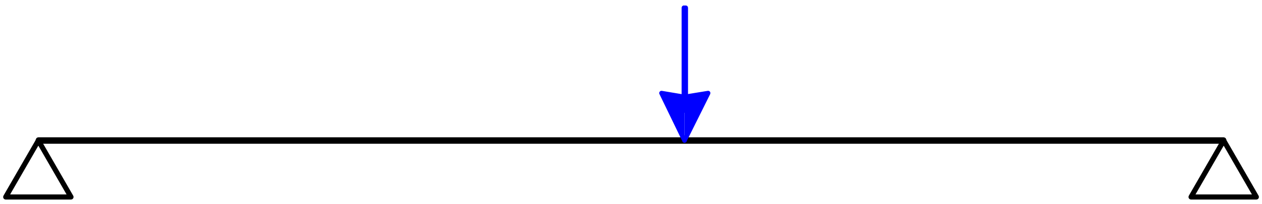
B_1

ال Tie تعتبر support للكمره B_1





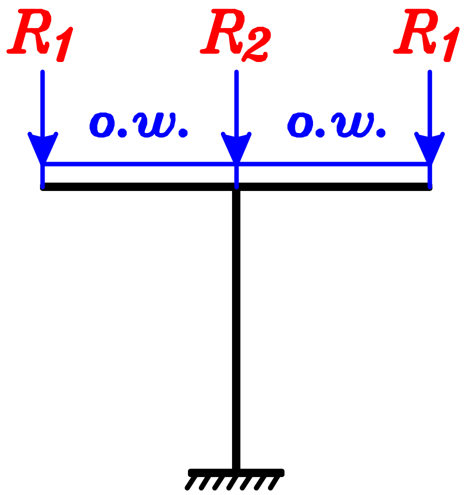
$R_1 + o.w.(Tie) + R_2$

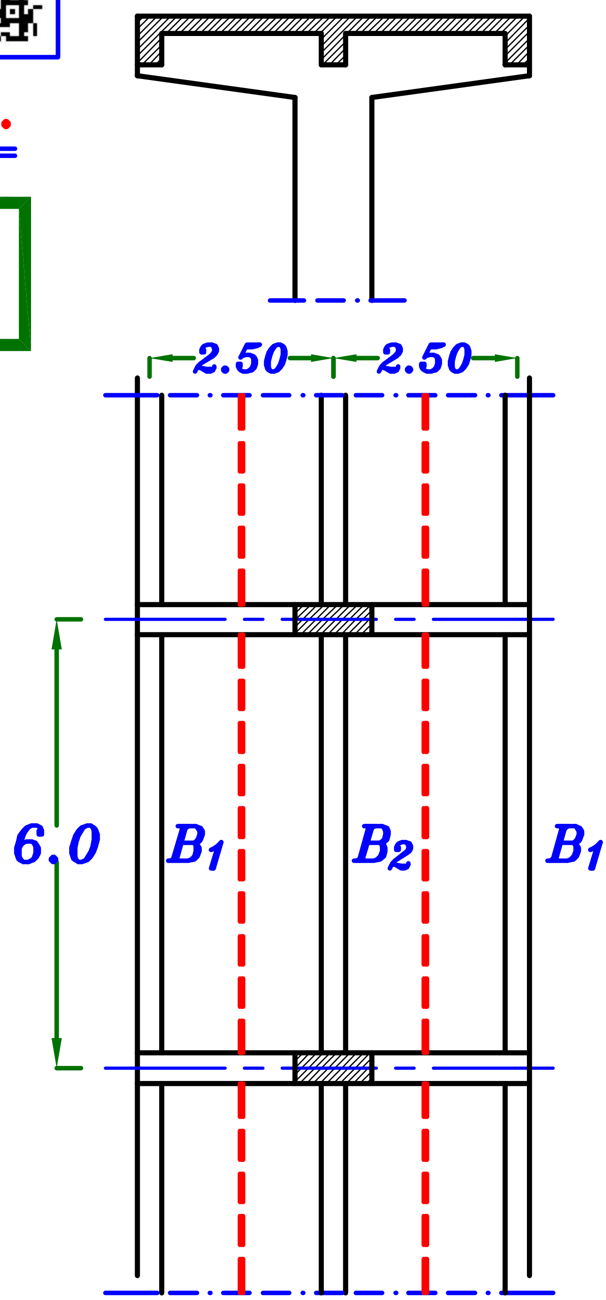


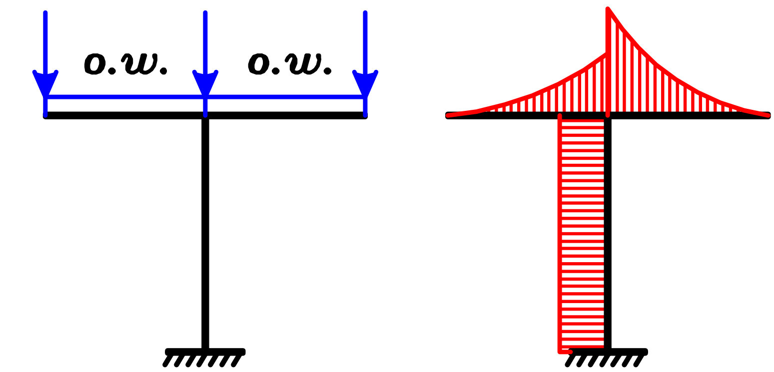
Notes.

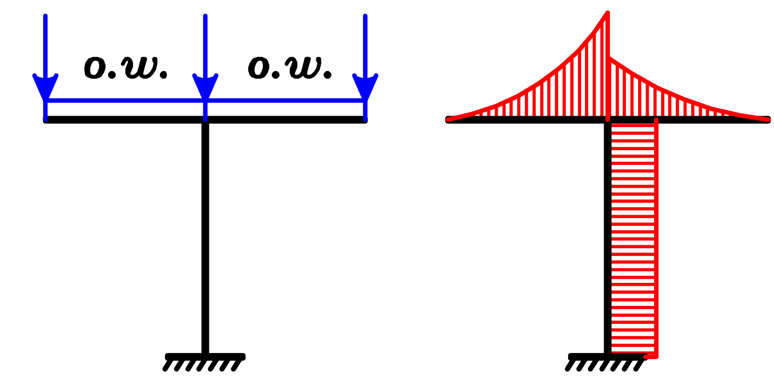
Double Cantilever Frame.

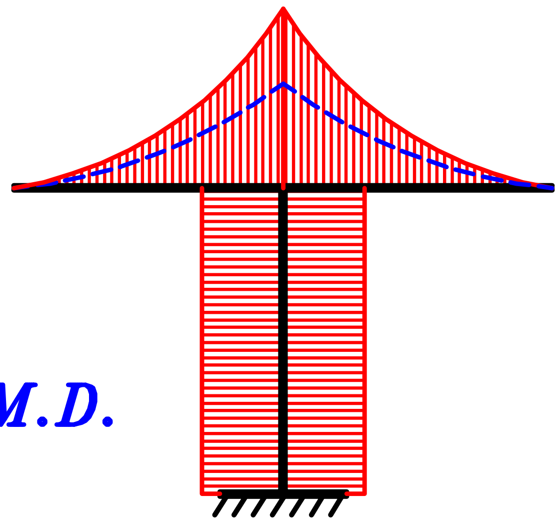
توجد ثلاث كمرات محمولين على ال **Frame**
البلاطات **one way** فى اتجاه الكمرات





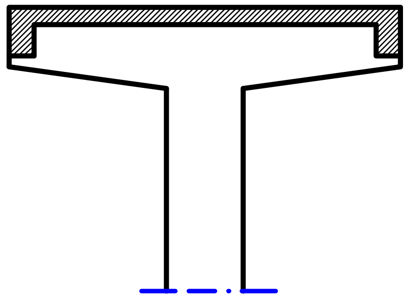


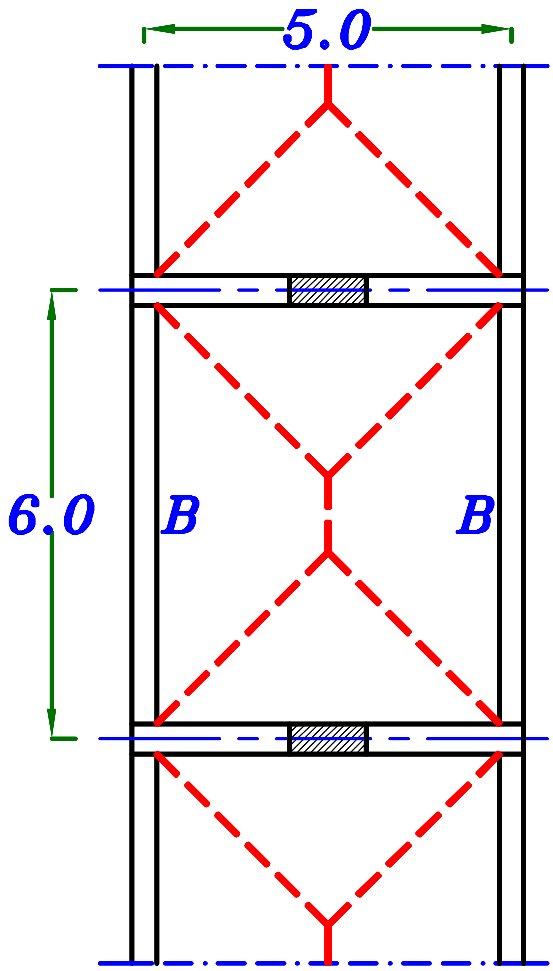


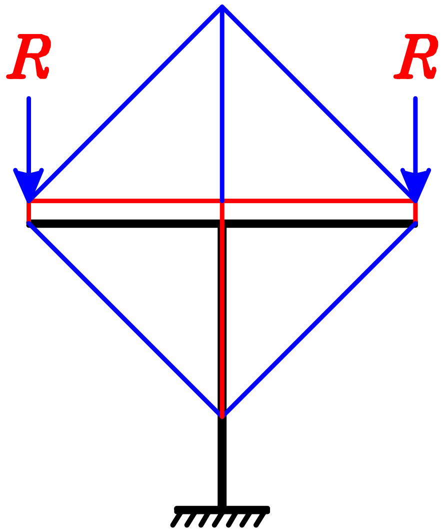


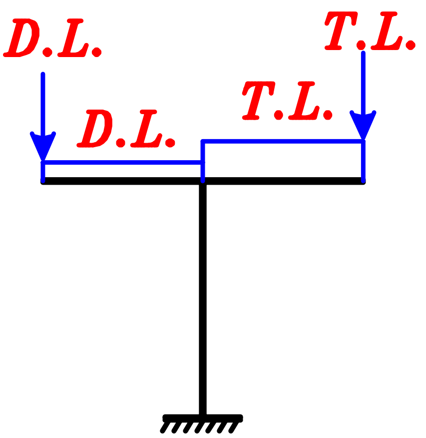
max−max B.M.D.

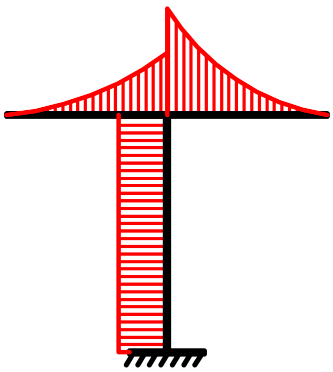
توجد كمرتان فقط محمولتان على الـ Frame
البلاطات Two way

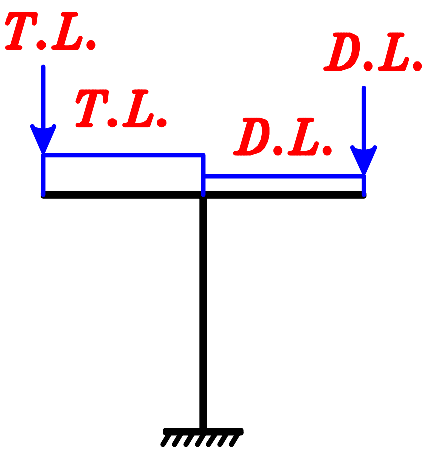


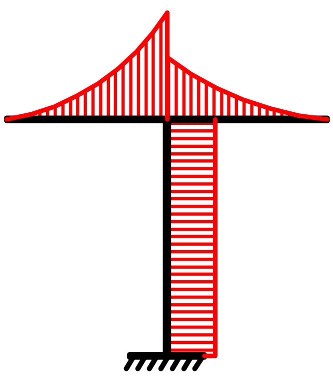


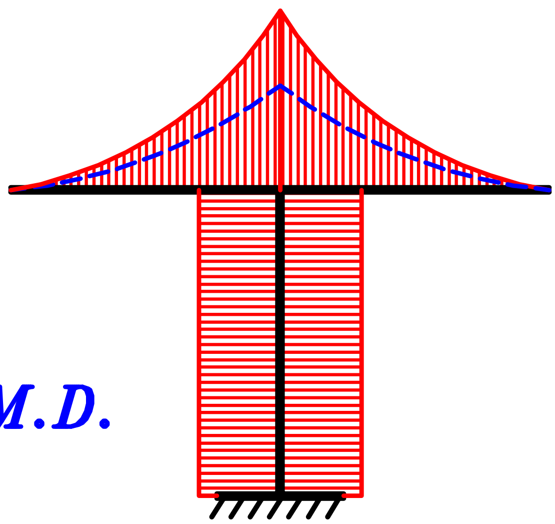






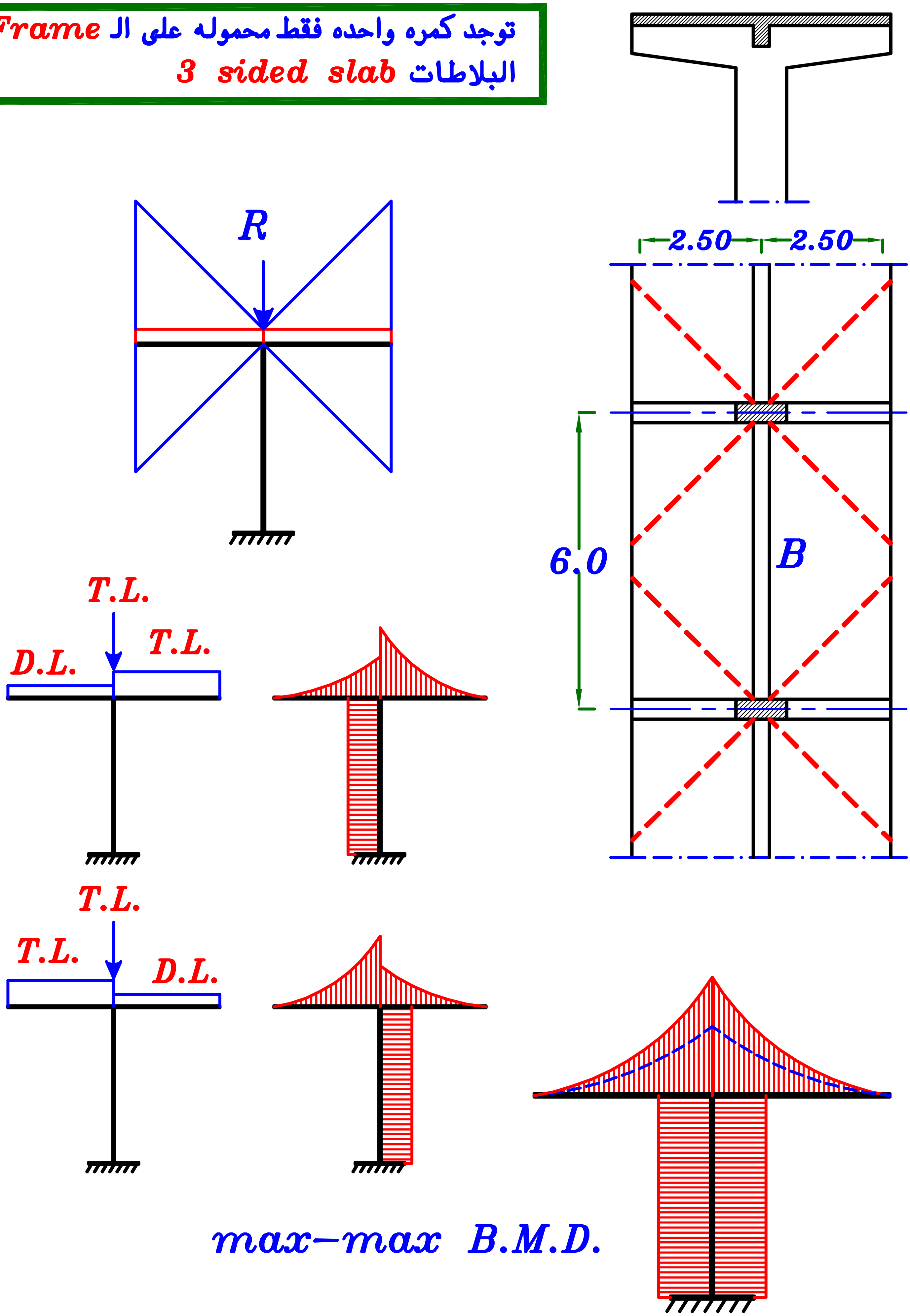






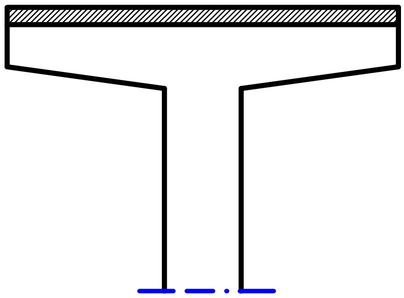
max-max B.M.D.

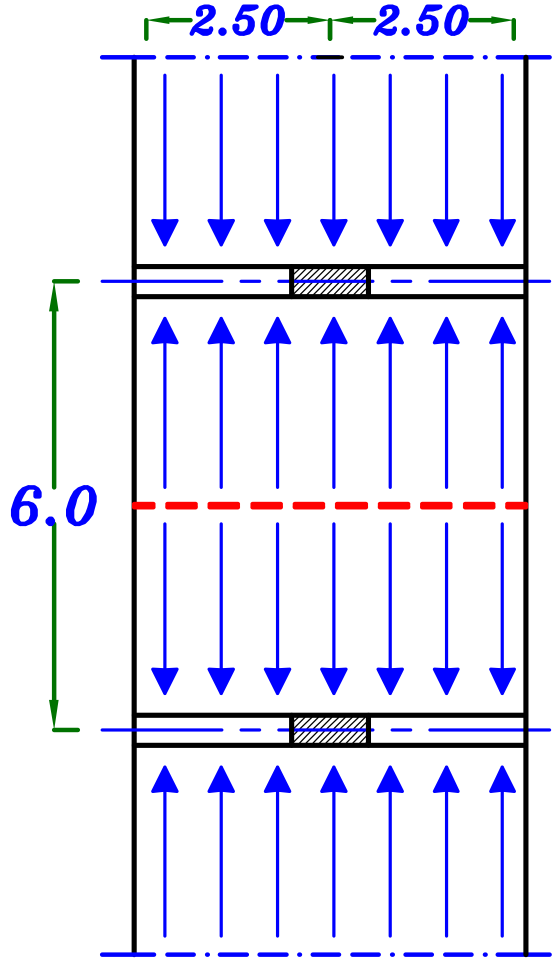
توجد كمره واحده فقط محموله على ال **Frame**
3 sided slab البلاطات

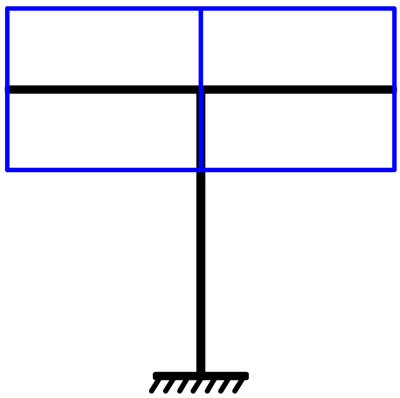


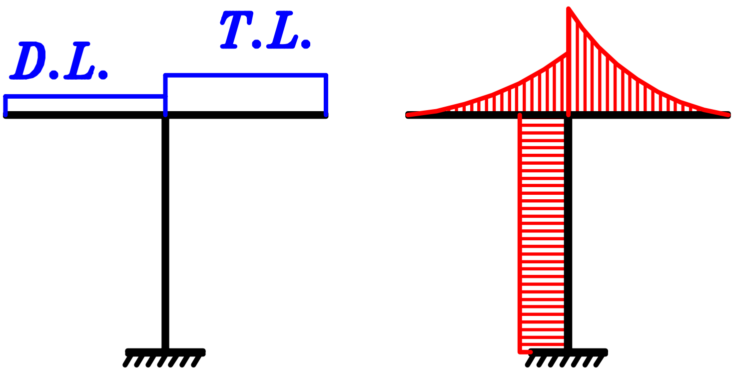
max-max B.M.D.

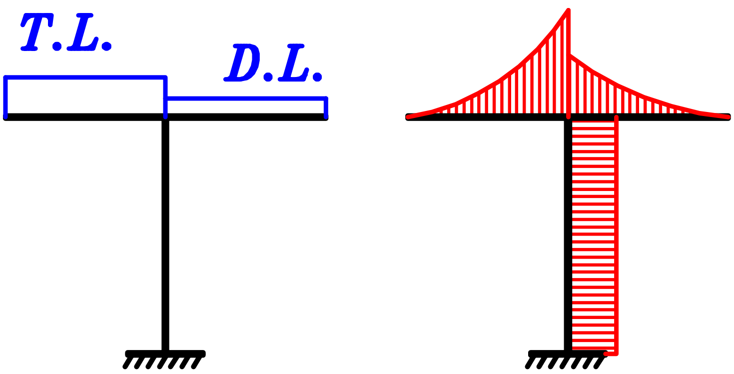
لا توجد كمرات محموله على ال **Frame**
البلاطات **one way** فى اتجاه ال **Frame**

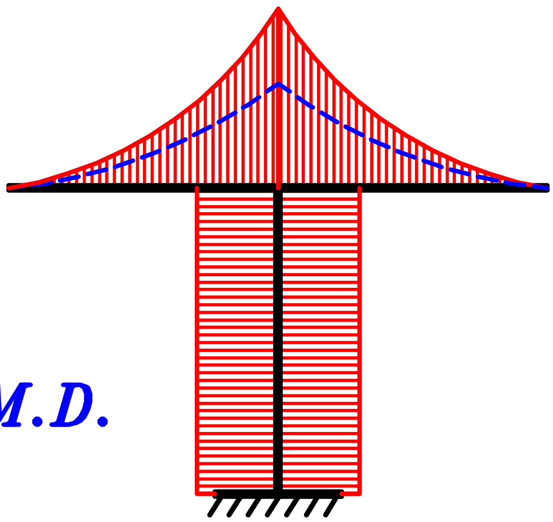






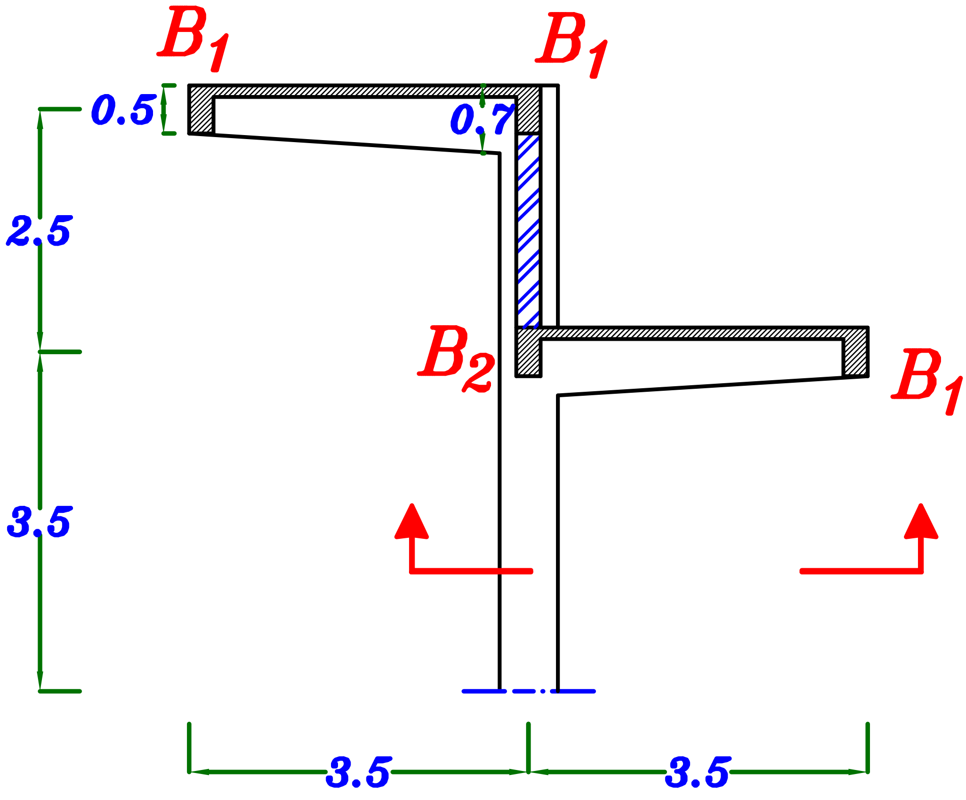






max-max B.M.D.

Example.



Data.

$t_s = 0.12\ m$

$F.C. = 1.50\ kN\backslash m^2$

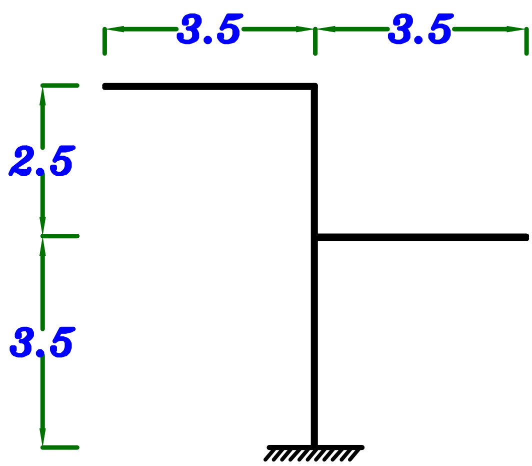
$L.L. = 2.0\ kN\backslash m^2$

$b_{Frame} = 0.30\ m$

$O.W.\ of\ Beam = 3.0\ kN\backslash m'$

$O.W.\ Walls = 18.0\ kN\backslash m^3$

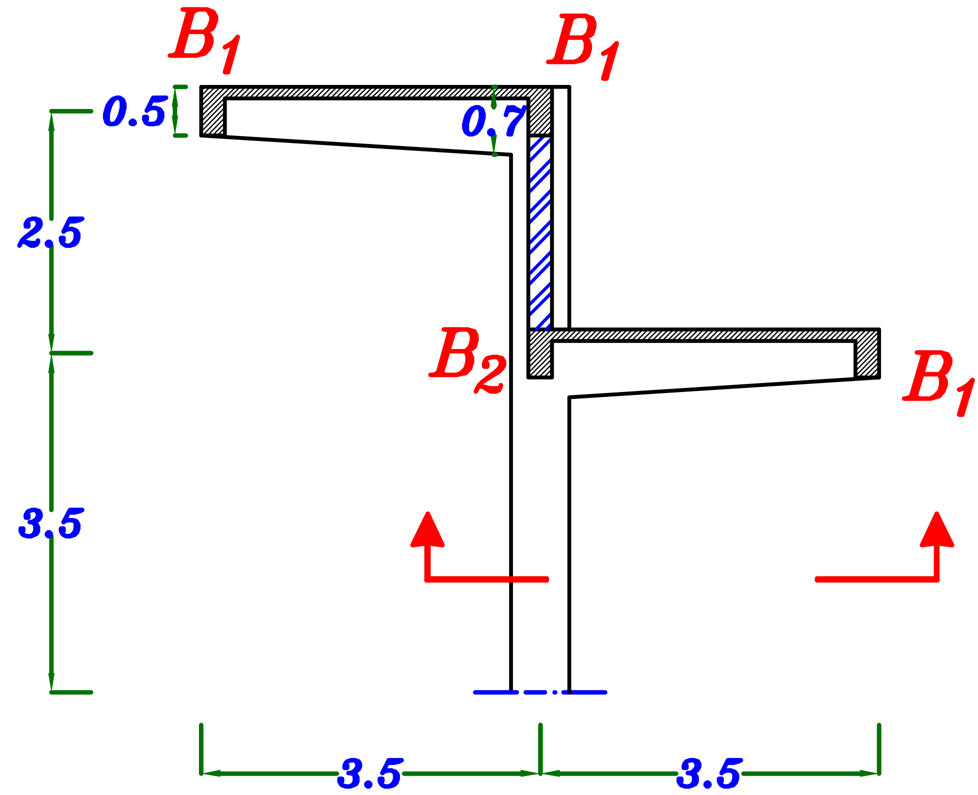
$Spacing = 5.0\ m$

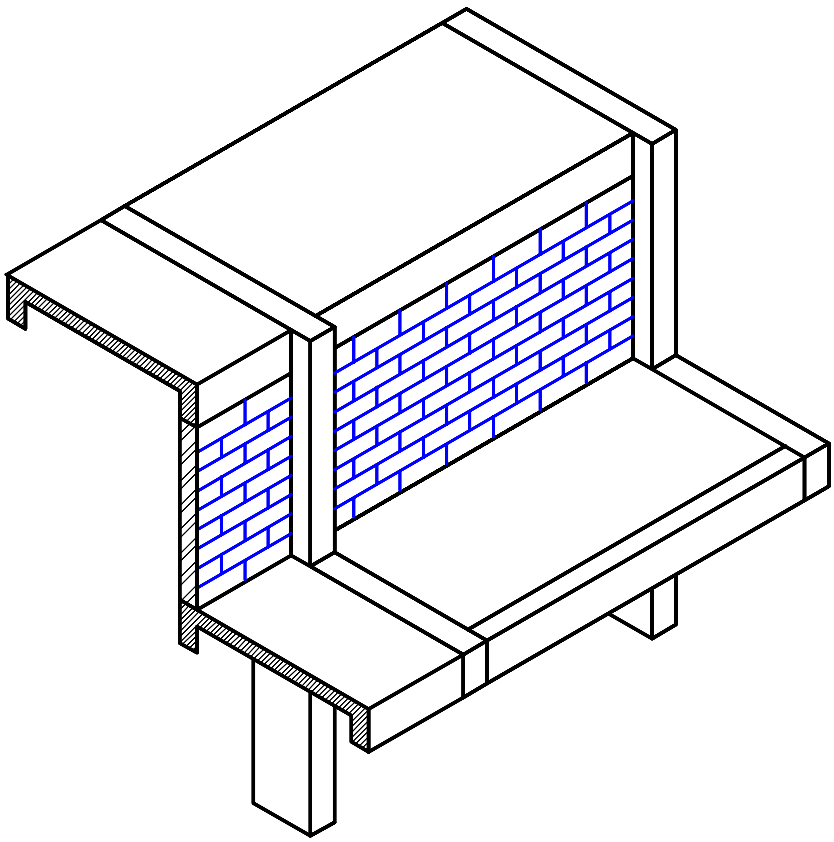


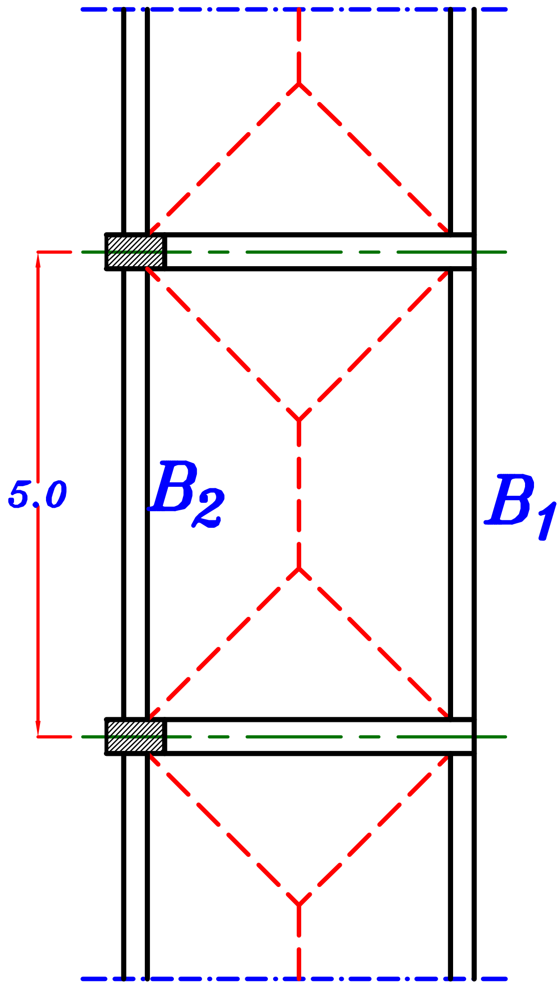
Req.

Draw absolute

S.F.D. , N.F.D. , B.M.D. For the Frame.


B1
B1
0.5
0.7
2.5
B2
B1
3.5
3.5
3.5




5.0
B2
B1

$b_{Frame} = 0.30\ m \qquad t_{Frame} = \frac{0.5+0.7}{2} = 0.6\ m$

$o.w._{Frame} = (b)\,(t)\,\gamma_c = 0.3 * 0.60 * 25 = 4.50\ kN\backslash m$

$o.w._{beam} = 3.0\ kN\backslash m$

---

g_s , p_s

$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.5 = 4.50\ kN\backslash m^2$

$p_s = L.L. = 2.0\ kN\backslash m^2$

$\boxed{g_s = 4.50\ kN\backslash m^2}\ ,\ \boxed{p_s = 2.0\ kN\backslash m^2}$

B_1

For Trapezoid $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.5}{5}\right) = 0.65$

$g_a = O.W. + \overset{\frown}{C_a}\, g_s\, \frac{L_s}{2} = 3.0 + 0.65\ (4.50)\left(\frac{3.5}{2}\right) = 8.10\ kN\backslash m'$

$p_a = C_a\, p_s\, \frac{L_s}{2} = 0.65\ (2.0)\left(\frac{3.5}{2}\right) = 2.30\ kN\backslash m'$

$w_a = g_a + p_a = 8.10 + 2.30 = 10.4\ kN\backslash m'$

$R_1 = g_a * Spacing = 8.10 * 5.0 = 40.5\ kN$ ---- D.L.

$= w_a * Spacing = 10.4 * 5.0 = 52.0\ kN$ ---- T.L.

$$\boxed{\begin{aligned} R_1 &= 40.5\ kN \text{ ---- D.L.} \\ &= 52.0\ kN \text{ ---- T.L.} \end{aligned}}$$

B_2

$g_a = O.W. + \overset{\frown}{C_a}\, g_s\, \frac{L_s}{2} + Wall = 3.0 + 0.65\ (4.50)\left(\frac{3.5}{2}\right) + 0.25\ (2.0)\ (18) = 17.1\ kN\backslash m'$

$p_a = C_a\, p_s\, \frac{L_s}{2} = 0.65\ (2.0)\left(\frac{3.5}{2}\right) = 2.30\ kN\backslash m'$

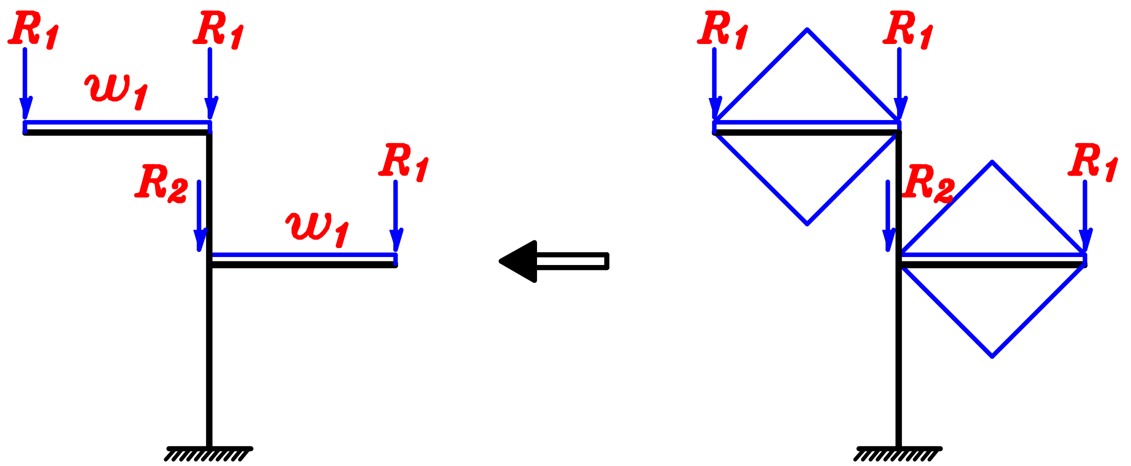
$w_a = g_a + p_a = 17.1 + 2.30 = 19.4\ kN\backslash m'$

$R_2 = g_a * Spacing = 17.1 * 5.0 = 85.5\ kN$ ---- D.L.

$= w_a * Spacing = 19.4 * 5.0 = 97.0\ kN$ ---- T.L.

$$\boxed{\begin{aligned} R_2 &= 85.5\ kN \text{ ---- D.L.} \\ &= 97.0\ kN \text{ ---- T.L.} \end{aligned}}$$

Loads on the Frame.



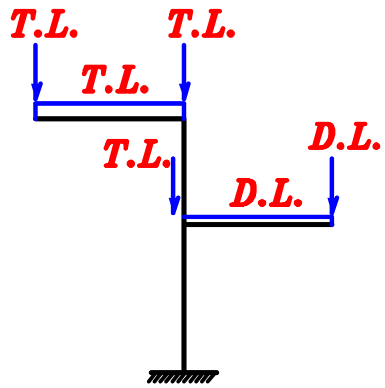
w_1

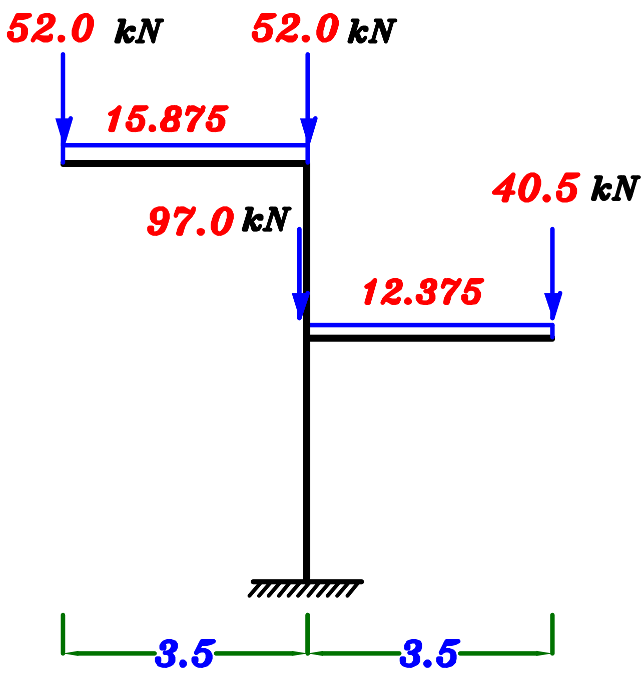
$$g_a = g_e = 0.W. + 2\,C_a\,g_s\,\frac{L_c}{2} = 4.50 + 2\left(\frac{1}{2}\right)(4.50)\left(\frac{3.5}{2}\right) = 12.375 \text{ kN\m}$$

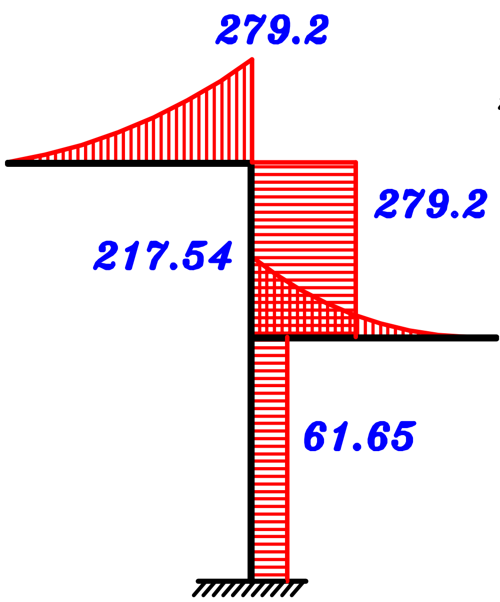
$$p_a = p_e = 2\,C_a\,p_s\,\frac{L_c}{2} = 2\left(\frac{1}{2}\right)(2.0)\left(\frac{3.5}{2}\right) = 3.50 \text{ kN\m`}$$

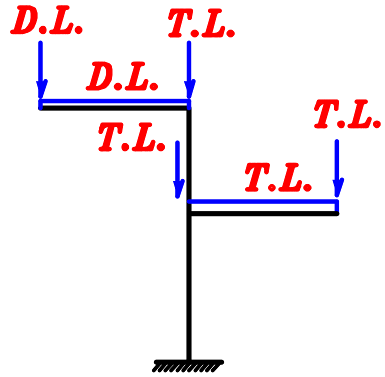
$$w_a = w_e = g_a + p_a = 12.375 + 3.50 = 15.875 \text{ kN\m`}$$

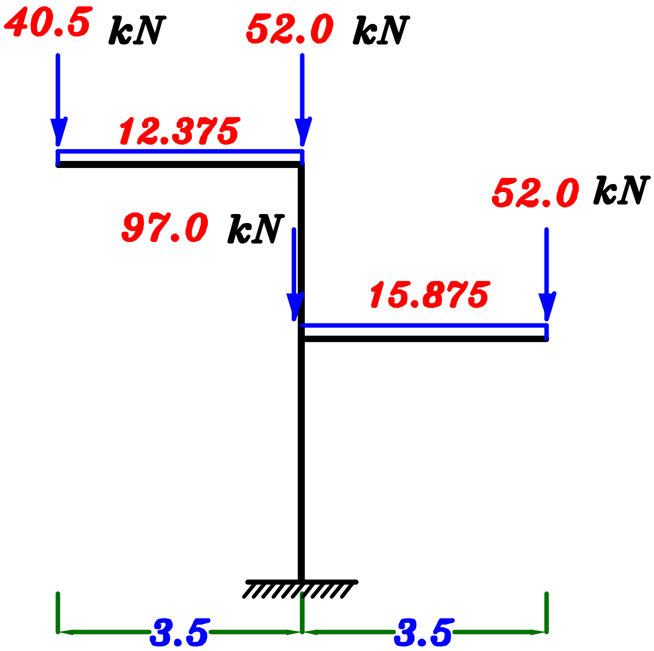
Cases of loading. (max–max moment)

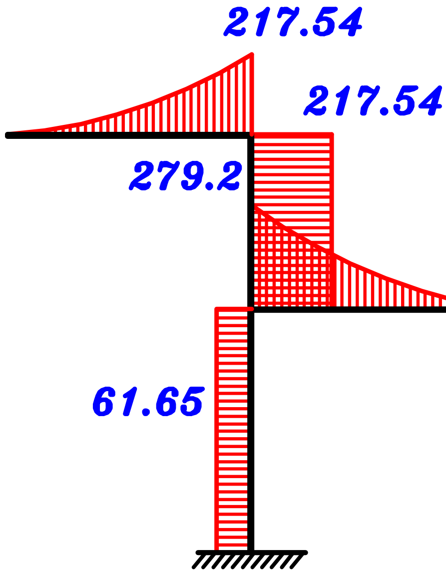


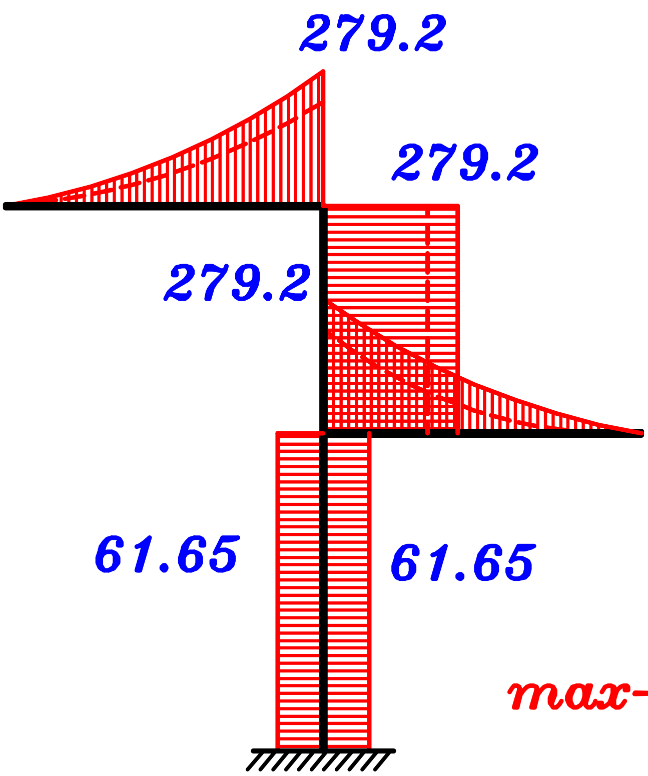





D.L.
T.L.
D.L.
T.L.
T.L.
T.L.

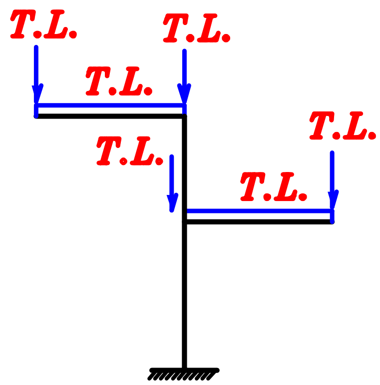

40.5 kN
52.0 kN
12.375
97.0 kN
52.0 kN
15.875
3.5
3.5

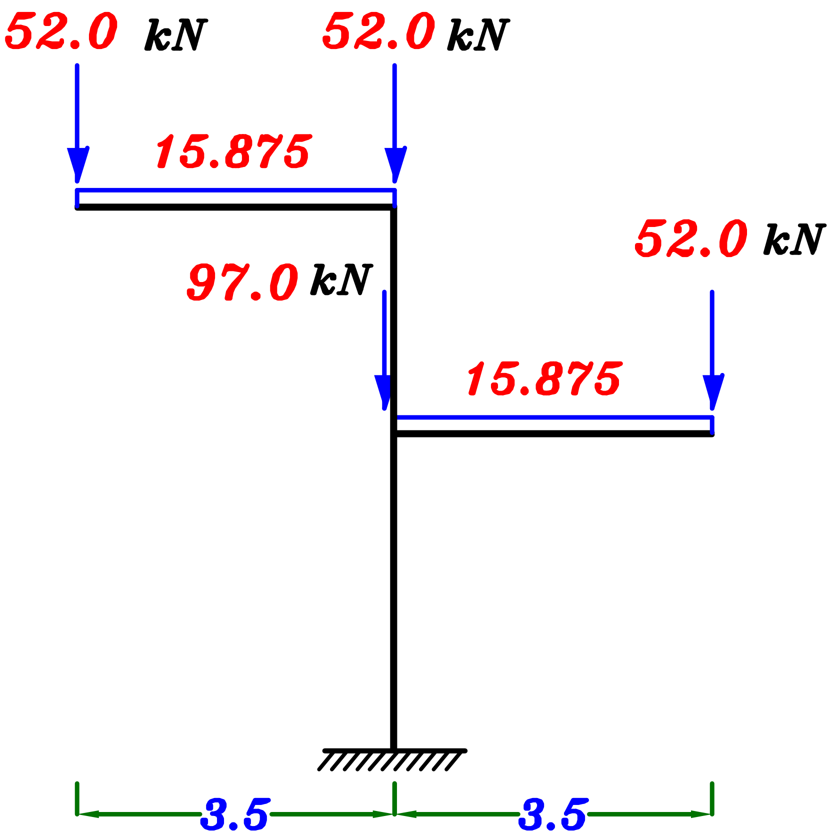

217.54
217.54
279.2
61.65

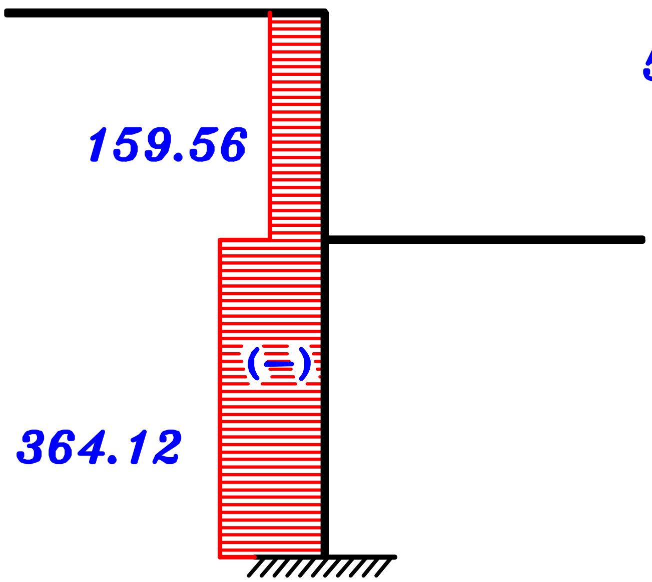

279.2
279.2
279.2
61.65
61.65

max-max B.M.D.

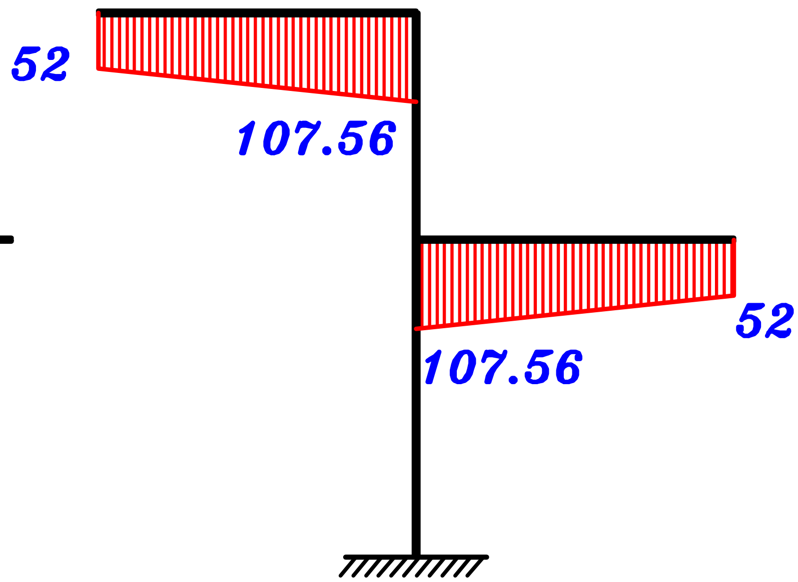
Cases of loading. (max-max Shear & Normal)





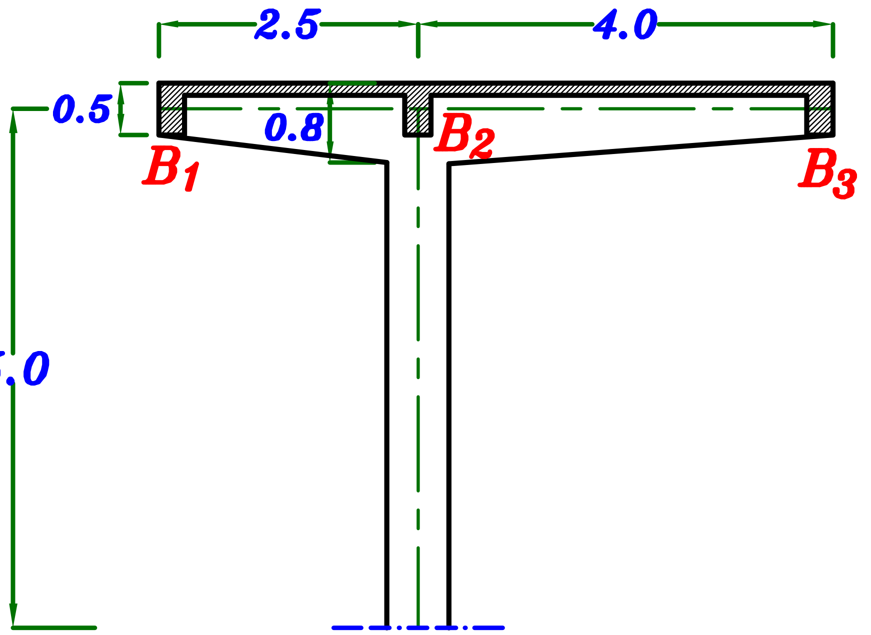


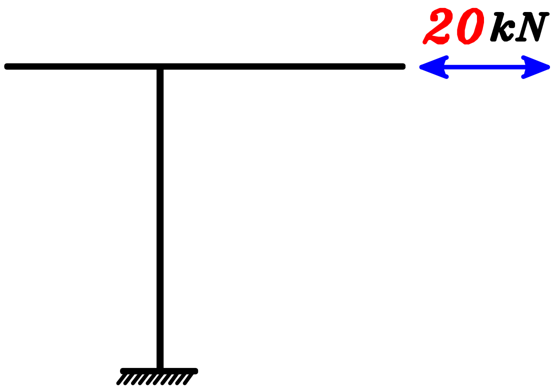
N.F.D.

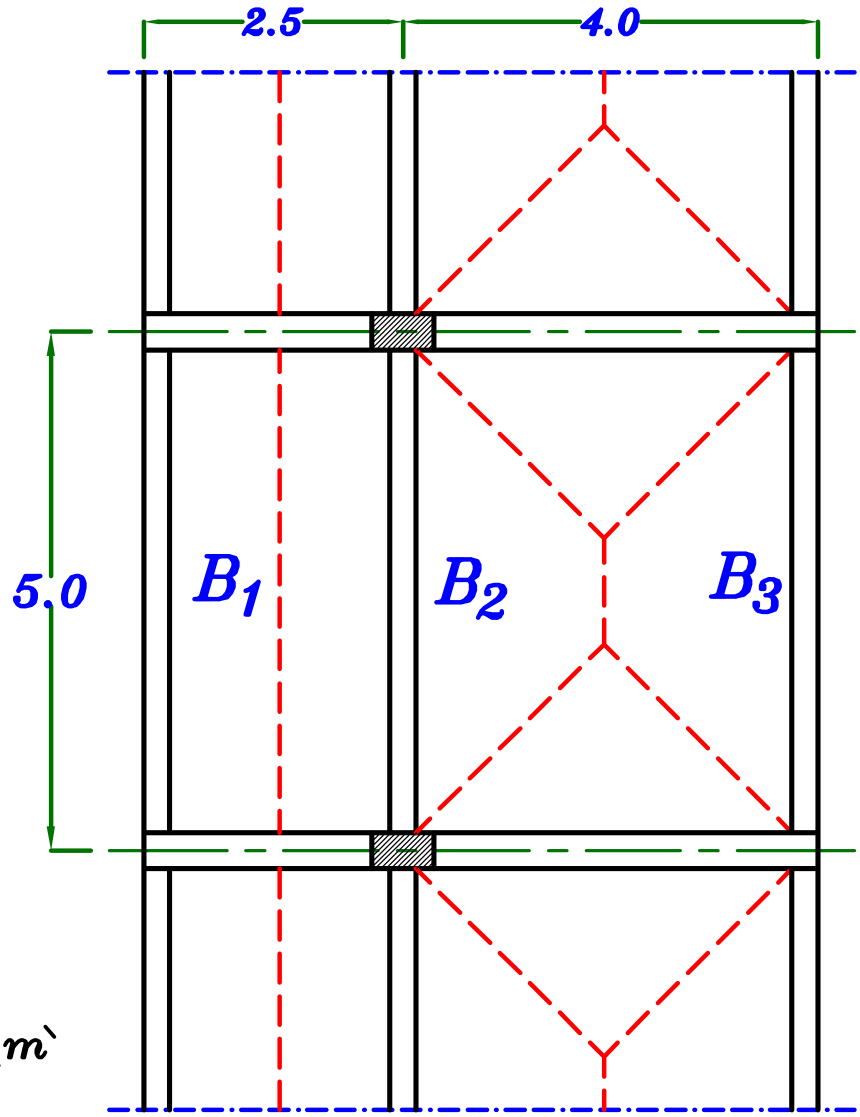


S.F.D.

Example.







Data.

$t_s = 0.12 \ m$

$F.C. = 2.50 \ kN\backslash m^2$

$L.L. = 1.0 \ kN\backslash m^2$

$b_{Frame} = 0.30 \ m$

$O.W.$ of Beam $= 3.0 \ kN\backslash m$

Spacing $= 5.0 \ m$

Req.

Draw absolute S.F.D. , N.F.D. , B.M.D. For the Frame.

$b_{Frame} = 0.3\ m \qquad t_{Frame} = \frac{0.5+0.8}{2} = 0.65\ m$

$o.w._{Frame} = (b)(t)\,\gamma_c = 0.3 * 0.65 * 25 = 4.875\ kN\backslash m$

$o.w._{beam} = 3.0\ kN\backslash m$

g_s, p_s

$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 2.5 = 5.50\ kN\backslash m^2$

$p_s = L.L. = 1.0\ kN\backslash m^2$

$\boxed{g_s = 5.50\ kN\backslash m^2}\ , \quad \boxed{p_s = 1.0\ kN\backslash m^2}$

B_1

$g_a = 0.W. + g_s \frac{L_s}{2} = 3.0 + (5.50)\left(\frac{2.5}{2}\right) = 9.80\ kN\backslash m'$

$p_a = p_s \frac{L_s}{2} = (1.0)\left(\frac{2.5}{2}\right) = 1.25\ kN\backslash m'$

$w_a = g_a + p_a = 9.80 + 1.25 = 11.05\ kN\backslash m'$

$R_1 = g_a * Spacing = 9.80 * 5.0 = 49.0\ kN$ ---- D.L.

$= w_a * Spacing = 11.05 * 5.0 = 55.25\ kN$ ---- T.L.

$R_1 = 49.0\ kN$ ---- D.L.

$= 55.25\ kN$ ---- T.L.

B_2

For Trapezoid $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{5}\right) = 0.60$

$g_a = 0.W. + g_s \frac{L_s}{2} + C_a\, g_s \frac{L_s}{2} = 3.0 + (5.50)\left(\frac{2.5}{2}\right) + 0.60\,(5.50)\left(\frac{4}{2}\right) = 16.47\ kN\backslash m'$

$p_a = p_s \frac{L_s}{2} + C_a\, p_s \frac{L_s}{2} = (1.0)\left(\frac{2.5}{2}\right) + 0.60\,(1.0)\left(\frac{4}{2}\right) = 2.45\ kN\backslash m'$

$w_a = g_a + p_a = 16.47 + 2.45 = 18.92\ kN\backslash m'$

$R_2 = g_a * Spacing = 16.47 * 5.0 = 82.35\ kN$ ----- D.L.

$= w_a * Spacing = 18.92 * 5.0 = 94.6\ kN$ ----- T.L.

$R_2 = 82.35\ kN$ ----- D.L.

$= 94.6\ kN$ ----- T.L.

B_3

For Trapezoid $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{5}\right) = 0.60$

$$g_a = O.W. + \overset{\frown}{C_a}\, g_s \frac{L_s}{2} = 3.0 + 0.60\ (5.50)\left(\frac{4}{2}\right) = 9.60 \quad kN\backslash m'$$

$$p_a = C_a\, p_s \frac{L_s}{2} = 0.60\ (1.0)\left(\frac{4}{2}\right) = 1.20 \quad kN\backslash m'$$

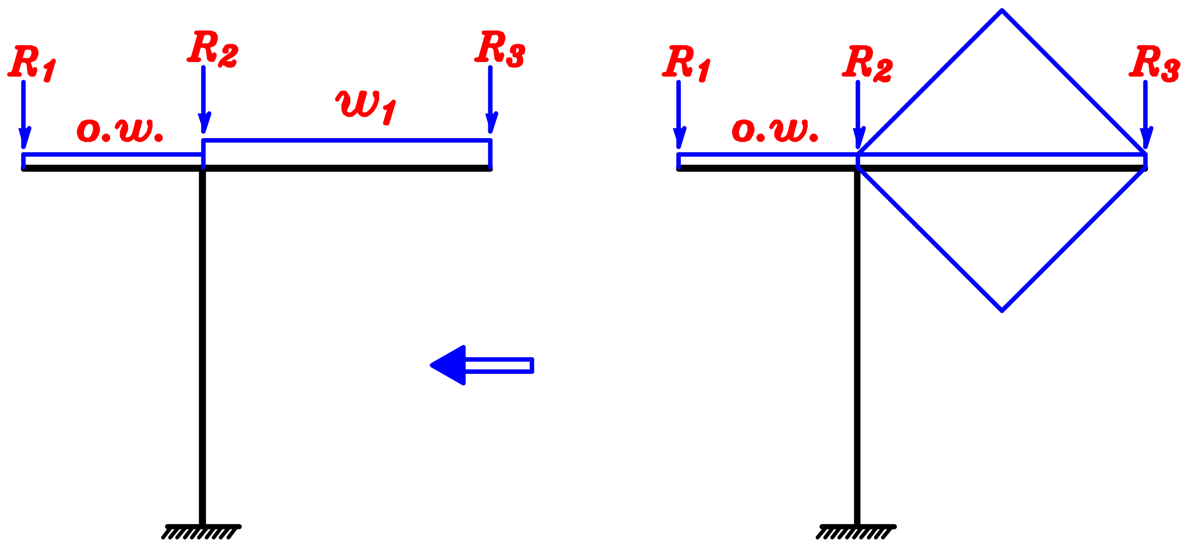
$$w_a = g_a + p_a = 9.60 + 1.20 = 10.8 \quad kN\backslash m'$$

$$R_3 = g_a * Spacing = 9.60 * 5.0 = 48.0\ kN \text{ ---- D.L.}$$

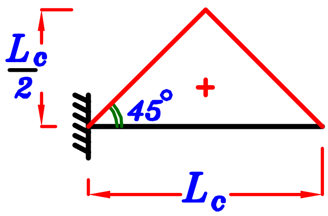
$$= w_a * Spacing = 10.8 * 5.0 = 54.0\ kN \text{ ---- T.L.}$$

$$\boxed{\begin{aligned} R_3 &= 48.0\ kN \text{ ---- D.L.} \\ &= 54.0\ kN \text{ ---- T.L.} \end{aligned}}$$

Loads on the Frame.



$$C_a = C_e = \frac{1}{2}$$



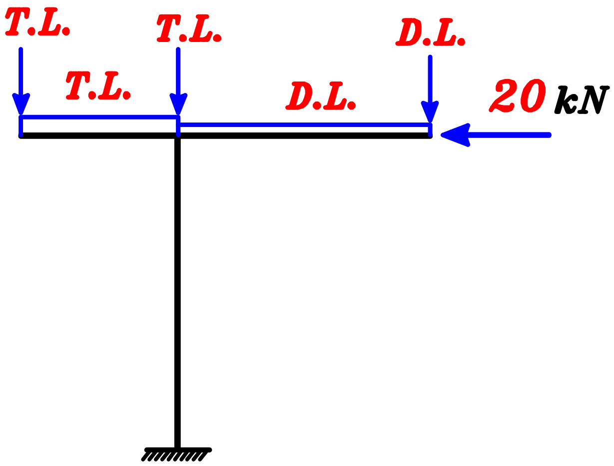
w_1

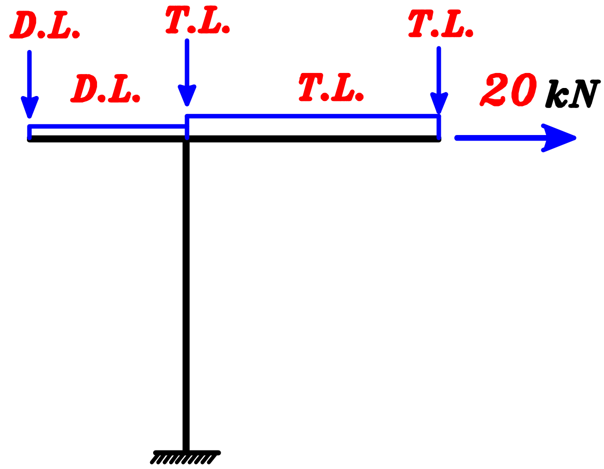
$$g_a = g_e = O.W. + 2\,\overset{\triangle}{C_a}\, g_s \frac{L_c}{2} = 4.875 + 2\left(\frac{1}{2}\right)(5.50)\left(\frac{4}{2}\right) = 15.875 \quad kN\backslash m'$$

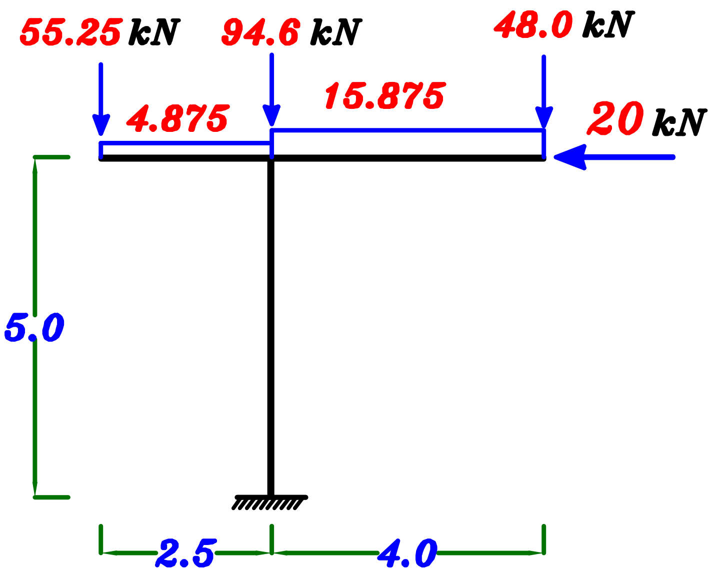
$$p_a = p_e = 2\, C_a\, p_s \frac{L_c}{2} = 2\left(\frac{1}{2}\right)(1.0)\left(\frac{4}{2}\right) = 2.0 \quad kN\backslash m'$$

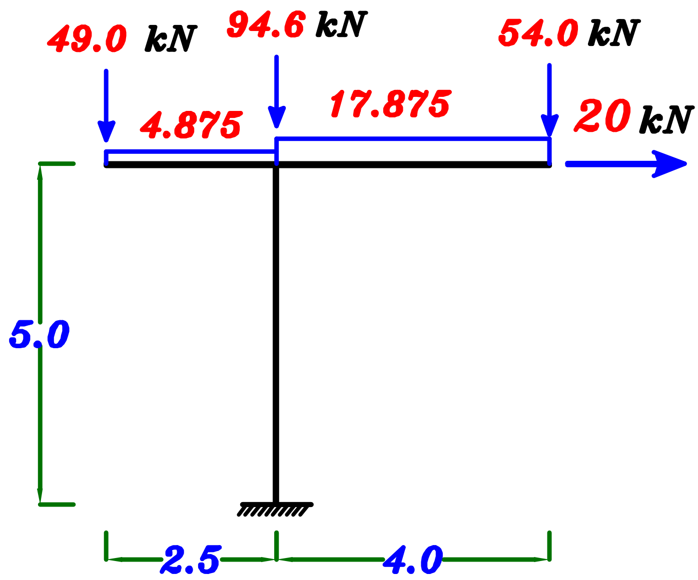
$$w_a = w_e = g_a + p_a = 15.875 + 2.0 = 17.875 \quad kN\backslash m'$$

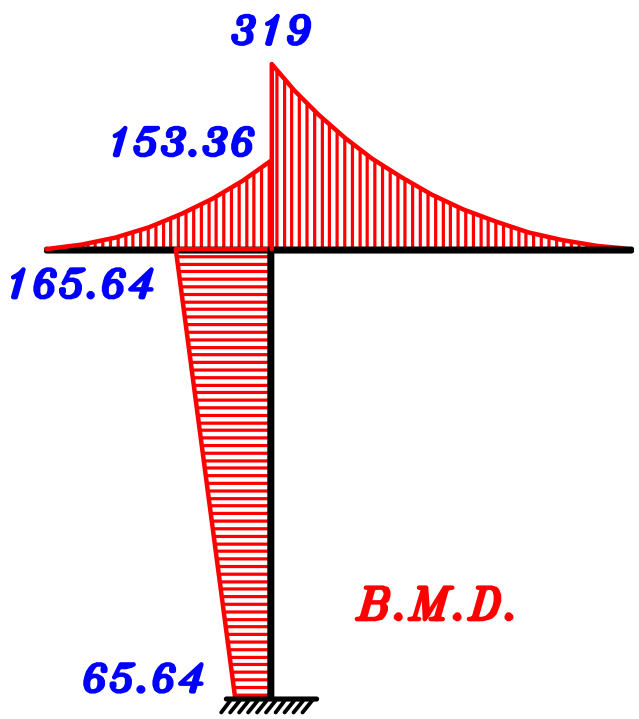
Cases of loading. (max-max moment)

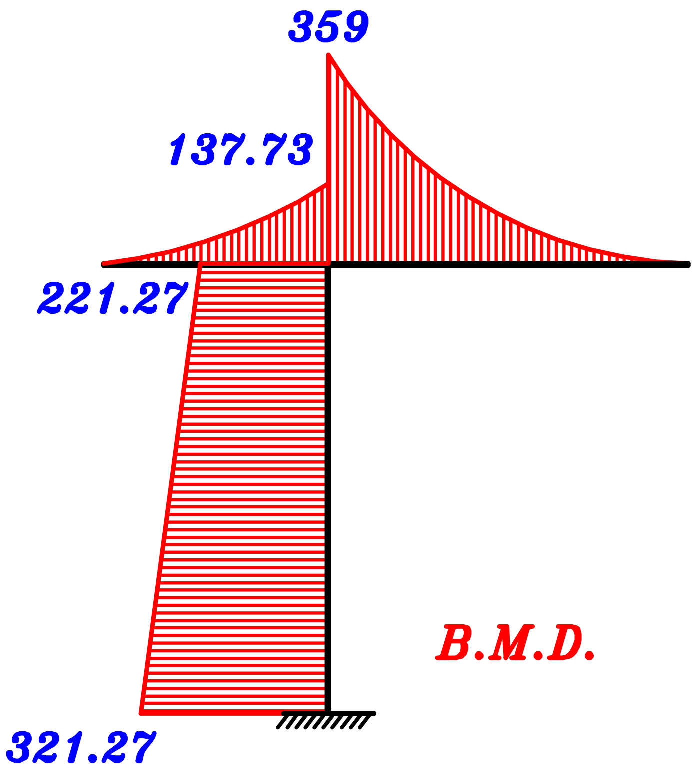


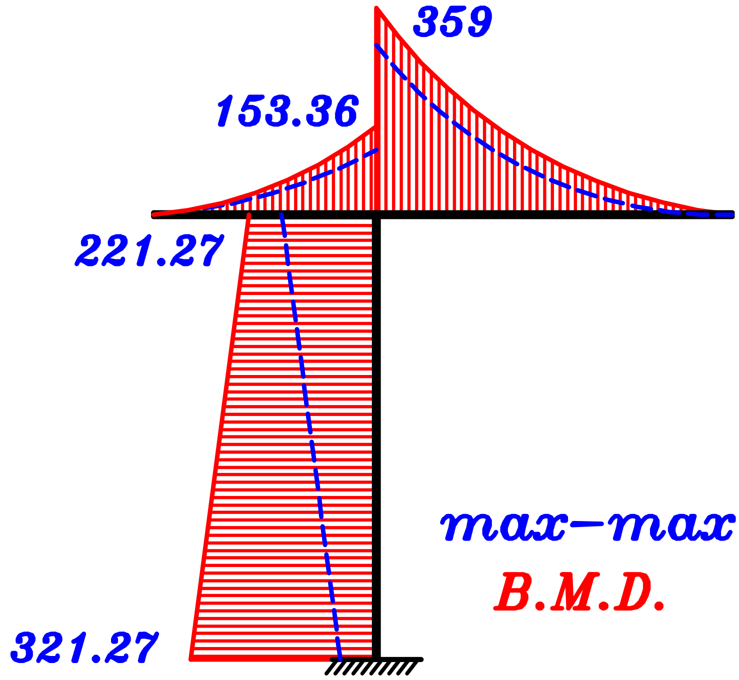




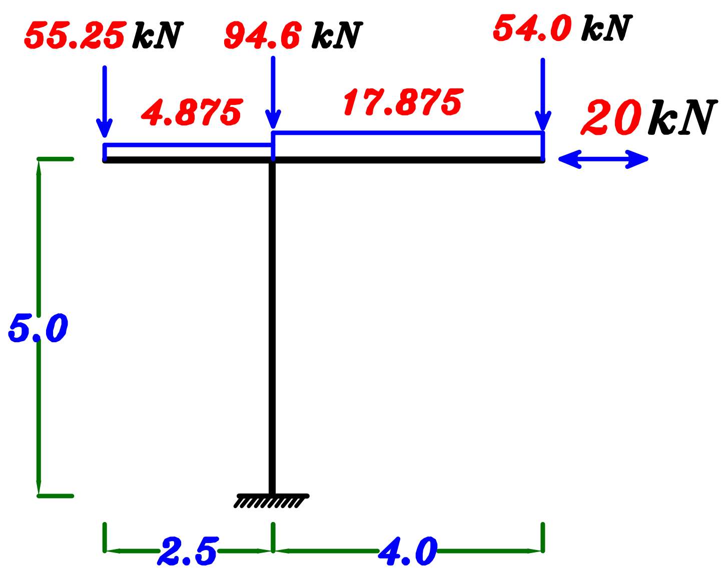


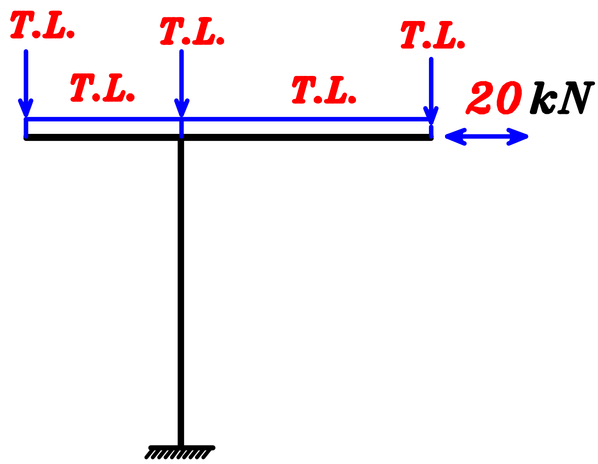


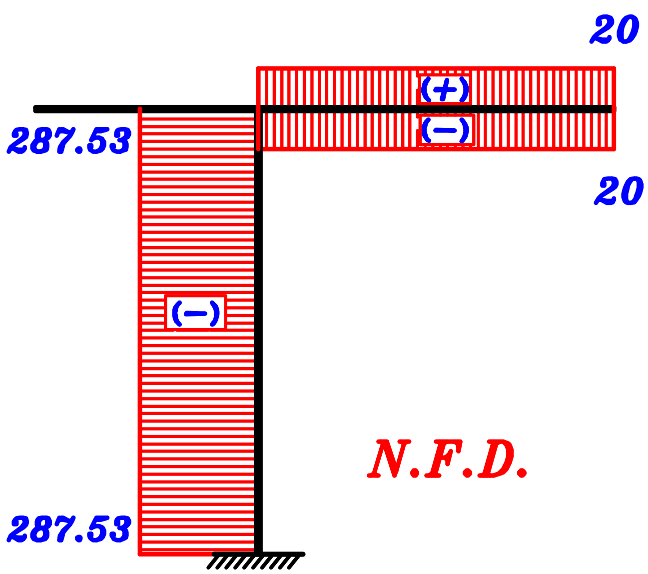


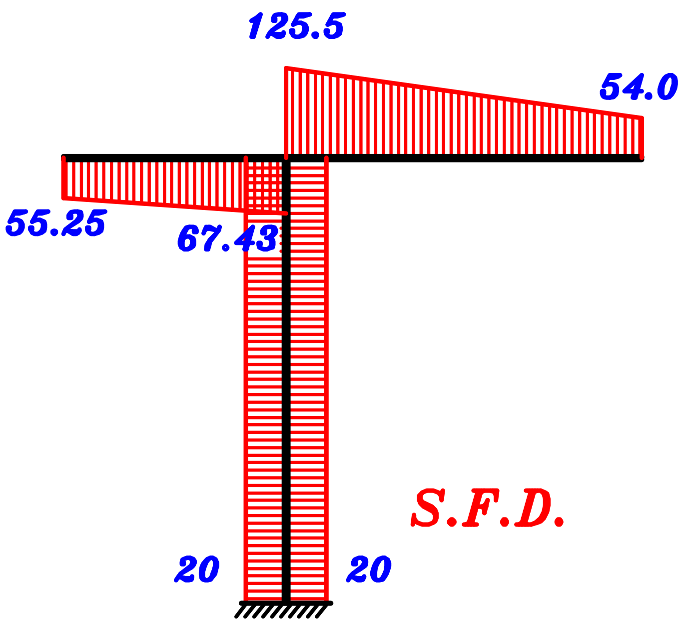


Cases of loading. (max-max Shear & Normal)









Example.

For the given Figure of structural plans, It is rquired to:

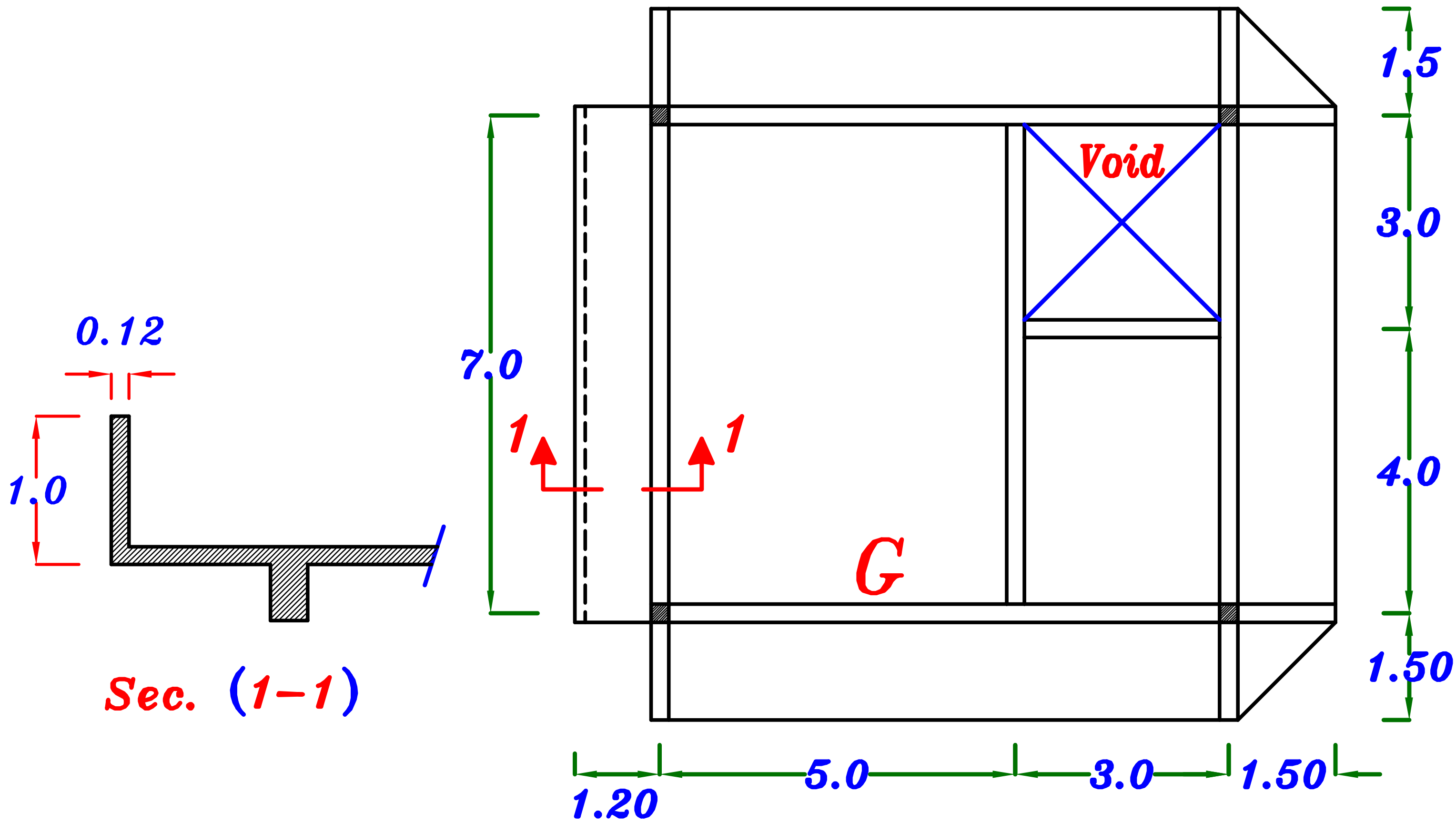
1- Draw a structural plan showing the shape of load distribution.

2- Calculate the equivalent loads For shear and bending For all Beams.

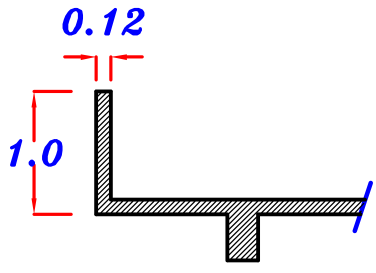
3- For girder marked (G), draw the S.F.D. and absolute (max-max) B.M.D.

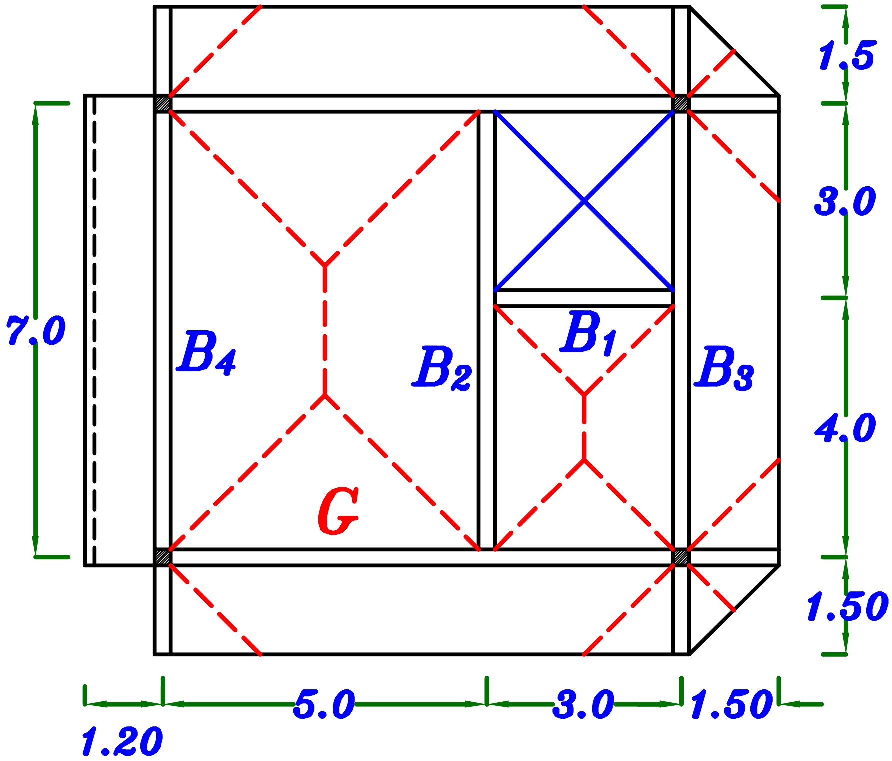
$o.w._{beams} = 3.0\ kN\backslash m$ $o.w._{girder} = 6.0\ kN\backslash m$ $t_s = 0.12\ m$

$F.C. = 1.5\ kN\backslash m^2$ $L.L. = 3.0\ kN\backslash m^2$



1- Draw a structural plan showing the shape of load distribution.





g_s , p_s

$$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.5 = 4.50 \ kN\backslash m^2$$

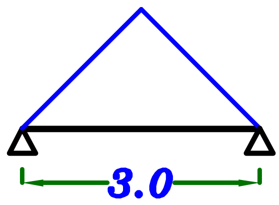
$$p_s = L.L. = 3.0 \ kN\backslash m^2$$

$$\boxed{g_s = 4.50 \ kN\backslash m^2} \ , \ \boxed{p_s = 3.0 \ kN\backslash m^2}$$

2- Calculate the equivalent working loads For shear and moment For beams B_1, B_2, B_3 & B_4.

B_1

For Triangle $C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$



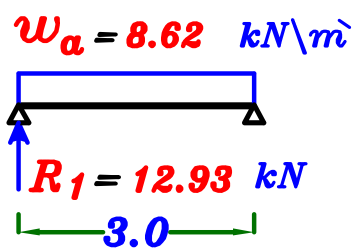
Load For Shear.

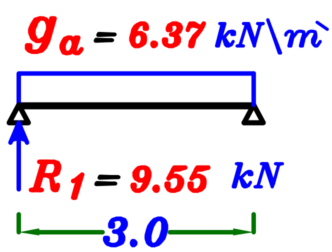
$$g_a = O.W. + C_a \ g_s \frac{L_s}{2} = 3.0 + \frac{1}{2}(4.50)(\frac{3.0}{2}) = 6.37 \ kN\backslash m$$

$$p_a = C_a \ p_s \frac{L_s}{2} = \frac{1}{2}(3.0)(\frac{3.0}{2}) = 2.25 \ kN\backslash m$$

$$w_a = g_a + p_a = 6.37 + 2.25 = 8.62 \ kN\backslash m$$

$$\boxed{\begin{aligned} R_1 &= 9.55 \ kN \text{ ---- D.L.} \\ &= 12.93 \ kN \text{ ---- T.L.} \end{aligned}}$$





Load For Moment.

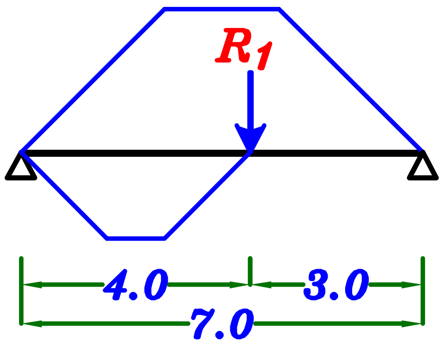
$$g_e = 0.W. + C_e\ g_s \frac{L_s}{2} = 3.0 + \frac{2}{3}(4.50)\left(\frac{3.0}{2}\right) = 7.50\ kN\backslash m$$

$$p_e = C_e\ p_s \frac{L_s}{2} = \frac{2}{3}(3.0)\left(\frac{3.0}{2}\right) = 3.0\ kN\backslash m$$

$$w_e = g_a + p_a = 7.50 + 3.0 = 10.50\ kN\backslash m$$

B_2

For Trapezoid



$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5.0}{7.0}\right) = 0.64$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{5.0}{7.0}\right)^2 = 0.83$$

$$\frac{\sum area}{span} = \frac{\left(\frac{4+1}{2}\right)(1.5)}{7.0} = 0.53$$

Load For Shear.

$$g_a = o.w. + C_a\ g_s \frac{L_s}{2} + \frac{\sum area}{span} * g_s$$

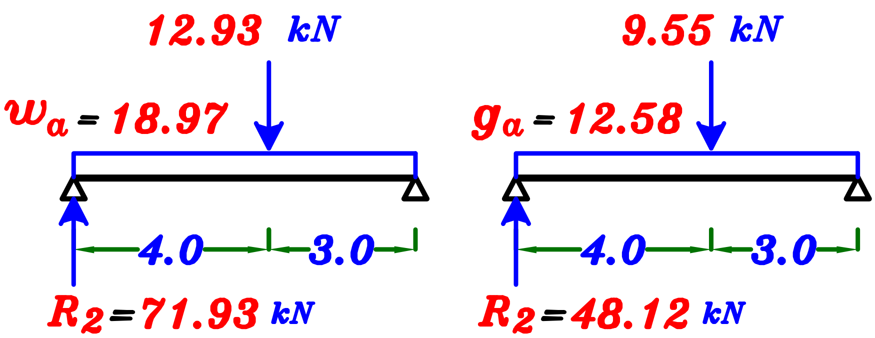
$$= 3.0 + (0.64)(4.50)\left(\frac{5.0}{2}\right) + (0.53)(4.50) = 12.58\ kN\backslash m$$

$$p_a = C_a\ p_s \frac{L_s}{2} + \frac{\sum area}{span} * p_s$$

$$= (0.64)(3.0)\left(\frac{5.0}{2}\right) + (0.53)(3.0) = 6.39\ kN\backslash m$$

$$w_a = g_a + p_a = 12.58 + 6.39 = 18.97\ kN\backslash m$$

$$\boxed{\begin{aligned} R_2 &= 48.12\ kN \text{---- D.L.} \\ &= 71.93\ kN \text{---- T.L.} \end{aligned}}$$



Load For Moment.

$$g_e = o.w. + C_e\, g_s \frac{L_s}{2} + \frac{\sum area}{span} * g_s$$

$$= 3.0 + (0.83)(4.50)\left(\frac{5.0}{2}\right) + (0.53)(4.50) = 14.72 \text{ kN}\backslash m'$$

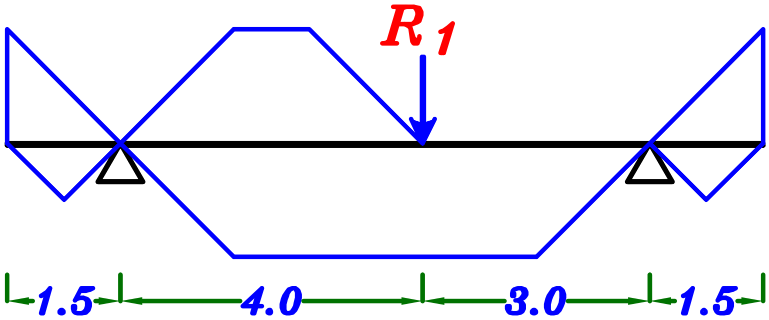
$$p_e = C_e\, p_s \frac{L_s}{2} + \frac{\sum area}{span} * p_s$$

$$= (0.83)(3.0)\left(\frac{5.0}{2}\right) + (0.53)(3.0) = 7.81 \text{ kN}\backslash m'$$

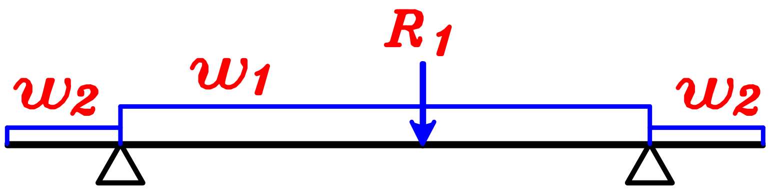
$$w_e = g_e + p_e = 14.72 + 7.81 = 22.53 \text{ kN}\backslash m'$$

B_3

w_1



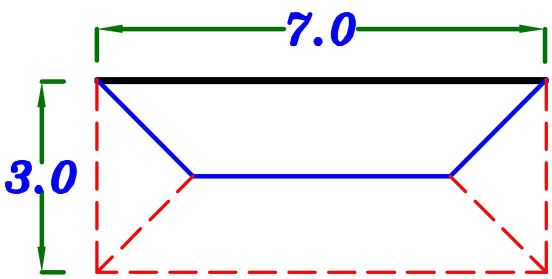
$$\frac{\sum area}{span} = \frac{\left(\frac{4+1}{2}\right)(1.5)}{7.0} = 0.53$$



For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{2L_c}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.0}{7.0}\right) = 0.78$$

$$C_e = 1 - \frac{1}{3}\left(\frac{2L_c}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.0}{7.0}\right)^2 = 0.94$$



Load For Shear.

$$g_{1a} = o.w. + C_a\, g_s\, L_c + \frac{\sum area}{span} * g_s$$

$$= 3.0 + (0.78)(4.50)(1.5) + (0.53)(4.50) = 10.65 \text{ kN}\backslash m'$$

$$p_{1a} = C_a\, p_s\, L_c + \frac{\sum area}{span} * p_s$$

$$= (0.78)(2.0)(1.5) + (0.53)(2.0) = 3.4 \text{ kN}\backslash m'$$

$$w_{1a} = g_{1a} + p_{1a} = 10.65 + 3.4 = 14.05 \text{ kN}\backslash m'$$

Load For Moment.

$$g_{1e} = o.w. + C_e \; g_s \, L_c + \frac{\sum area}{span} * g_s$$

$$= 3.0 + (0.94)(4.50)(1.5) + (0.53)(4.50) = 11.73 \; kN\backslash m'$$

$$p_{1e} = C_e \; p_s \frac{L_s}{2} + \frac{\sum area}{span} * p_s$$

$$= (0.94)(2.0)\left(\frac{3.0}{2}\right) + (0.53)(2.0) = 3.88 \; kN\backslash m'$$

$$w_{1e} = g_{1e} + p_{1e} = 11.73 + 3.88 = 15.61 \; kN\backslash m'$$

$\underline{\underline{w2}}$

For Triangle $C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$

For Triangle $C_a = \frac{1}{2}$, $C_e = \frac{1}{2}$

Load For Shear.

$$g_{2a} = o.w. + C_a \; g_s \, L_c + C_a \; g_s \frac{L_c}{2}$$

$$= 3.0 + \left(\frac{1}{2}\right)(4.50)(1.5) + \left(\frac{1}{2}\right)(4.50)\left(\frac{1.5}{2}\right) = 8.06 \; kN\backslash m'$$

$$p_{2a} = C_a \; p_s \, L_c + C_a \; p_s \frac{L_c}{2}$$

$$= \left(\frac{1}{2}\right)(2.0)(1.5) + \left(\frac{1}{2}\right)(2.0)\left(\frac{1.5}{2}\right) = 2.25 \; kN\backslash m'$$

$$w_{2a} = g_{2a} + p_{2a} = 8.06 + 2.25 = 10.31 \; kN\backslash m'$$

Load For Moment.

$$g_{2e} = o.w. + C_e \; g_s \, L_c + C_e \; g_s \frac{L_c}{2}$$

$$= 3.0 + \left(\frac{2}{3}\right)(4.50)(1.5) + \left(\frac{1}{2}\right)(4.50)\left(\frac{1.5}{2}\right) = 9.18 \; kN\backslash m'$$

$$p_{2e} = C_e \; p_s \, L_c + C_e \; p_s \frac{L_c}{2}$$

$$= \left(\frac{2}{3}\right)(2.0)(1.5) + \left(\frac{1}{2}\right)(2.0)\left(\frac{1.5}{2}\right) = 2.75 \; kN\backslash m'$$

$$w_{2e} = g_{2a} + p_{2a} = 9.18 + 2.75 = 11.93 \; kN\backslash m'$$

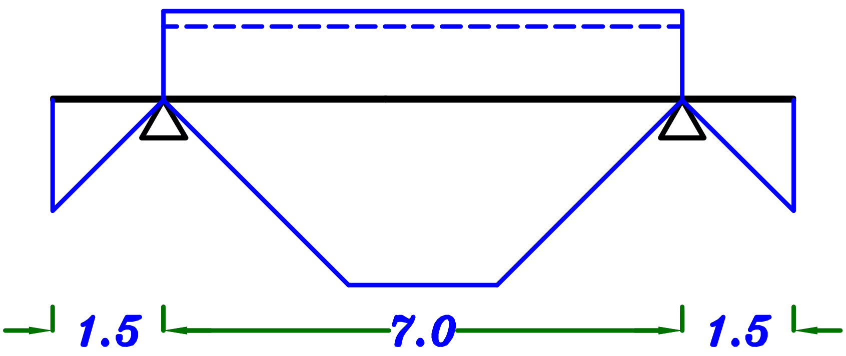
B_4

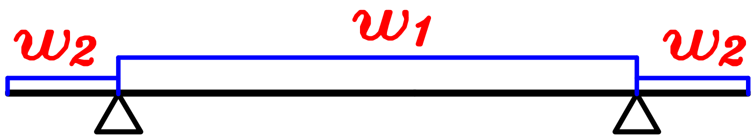
w_1

For Trapezoid

$C_a = 0.64$

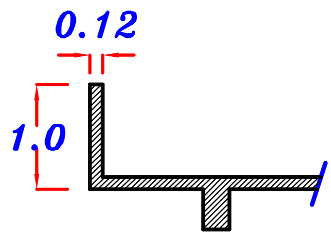
$C_e = 0.83$





$$\text{Parapet weight} = b * h * \gamma_c$$

$$= 0.12 * 1.0 * 25 = 3.0 \ kN/m$$



Load For Shear.

$$g_{1a} = o.w. + C_a \ g_s \ \frac{L_s}{2} + g_s \ L_c + Parapet$$

$$= 3.0 + (0.64)(4.50)\left(\frac{5.0}{2}\right) + (4.5)(1.2) + 3.0 = 18.60 \ kN\backslash m`$$

$$p_{1a} = C_a \ p_s \ \frac{L_s}{2} + p_s \ L_c$$

$$= (0.64)(3.0)\left(\frac{5.0}{2}\right) + (3.0)(1.2) = 8.4 \ kN\backslash m`$$

$$w_{1a} = g_{1a} + p_{1a} = 18.60 + 8.4 = 27.0 \ kN\backslash m`$$

Load For Moment.

$$g_{1e} = o.w. + C_e \ g_s \ \frac{L_s}{2} + g_s \ L_c + Parapet$$

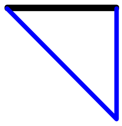
$$= 3.0 + (0.83)(4.50)\left(\frac{5.0}{2}\right) + (4.5)(1.2) + 3.0 = 20.73 \ kN\backslash m`$$

$$p_{1e} = C_e \ p_s \ \frac{L_s}{2} + p_s \ L_c$$

$$= (0.83)(3.0)\left(\frac{5.0}{2}\right) + (3.0)(1.2) = 9.82 \ kN\backslash m`$$

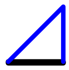
$$w_{1e} = g_{1e} + p_{1e} = 20.73 + 9.82 = 30.55 \ kN\backslash m`$$

w_2 For Triangle



$C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$

Load For Shear.



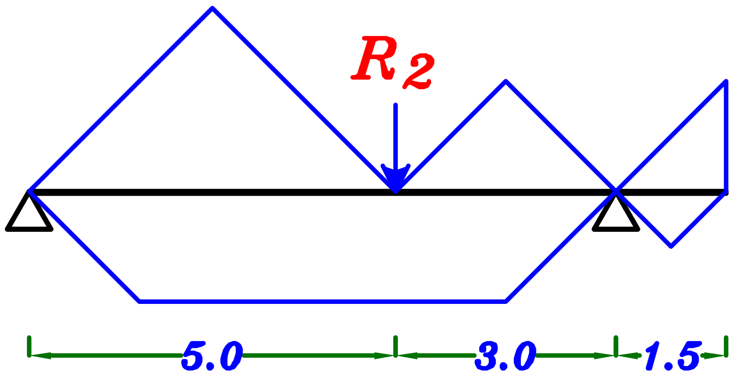
$$g_{2a} = o.w. + C_a\, g_s\, L_c = 3.0 + \left(\tfrac{1}{2}\right)(4.50)\,(1.5) = 6.37 \text{ kN\m`}$$

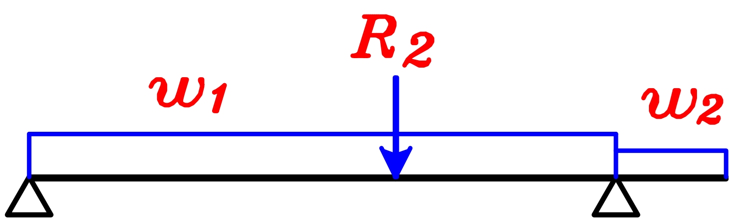
$$p_{2a} = C_a\, p_s\, L_c = \left(\tfrac{1}{2}\right)(2.0)\,(1.5) = 1.5 \text{ kN\m`}$$

$$w_{2a} = g_{2a} + p_{2a} = 6.37 + 1.5 = 7.87 \text{ kN\m`}$$

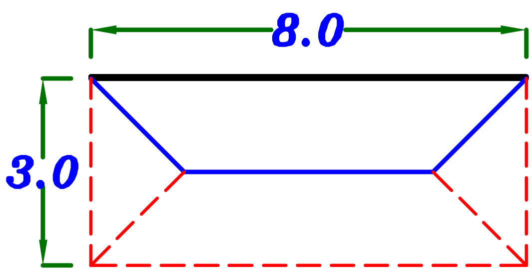
Loads on the girder G

w_1



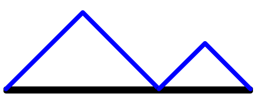


For Trapezoid



$$C_a = 1 - \frac{1}{2}\left(\frac{2L_c}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.0}{8.0}\right) = 0.81$$

$$C_e = 1 - \frac{1}{3}\left(\frac{2L_c}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.0}{8.0}\right)^2 = 0.95$$



$$\frac{\sum area}{span} = \frac{\left(\frac{1}{2}\right)(5)\,(2.5) + \left(\frac{1}{2}\right)(3)\,(1.5)}{8.0} = 1.062$$

Load For Shear.

$$g_{1a} = o.w. + C_a\, g_s\, L_c + \frac{\sum area}{span} * g_s$$

$$= 3.0 + (0.81)(4.50)(1.5) + (1.062)(4.50) = 13.24 \ kN\backslash m'$$

$$p_{1a} = C_a\, p_s\, L_c + \frac{\sum area}{span} * p_s$$

$$= (0.81)(2.0)(1.5) + (1.062)(2.0) = 4.55 \ kN\backslash m'$$

$$w_{1a} = g_{1a} + p_{1a} = 13.24 + 4.55 = 17.79 \ kN\backslash m'$$

Load For Moment.

$$g_{1e} = o.w. + C_e\, g_s\, L_c + \frac{\sum area}{span} * g_s$$

$$= 3.0 + (0.95)(4.50)(1.5) + (1.062)(4.50) = 14.19 \ kN\backslash m'$$

$$p_{1e} = C_e\, p_s\, L_c + \frac{\sum area}{span} * p_s$$

$$= (0.95)(2.0)(1.5) + (1.062)(2.0) = 4.97 \ kN\backslash m'$$

$$w_{1e} = g_{1e} + p_{1e} = 14.19 + 4.97 = 19.16 \ kN\backslash m'$$

$w2$

For Triangle $\quad C_a = \frac{1}{2} \ , \ C_e = \frac{2}{3}$

For Triangle $\quad C_a = \frac{1}{2} \ , \ C_e = \frac{1}{2}$

Load For Shear.

$$g_{2a} = o.w. + C_a\, g_s\, L_c + C_a\, g_s \frac{L_c}{2}$$

$$= 3.0 + (\tfrac{1}{2})(4.50)(1.5) + (\tfrac{1}{2})(4.50)(\tfrac{1.5}{2}) = 8.06 \ kN\backslash m'$$

$$p_{2a} = C_a\, p_s\, L_c + C_a\, p_s \frac{L_c}{2}$$

$$= (\tfrac{1}{2})(2.0)(1.5) + (\tfrac{1}{2})(2.0)(\tfrac{1.5}{2}) = 2.25 \ kN\backslash m'$$

$$w_{2a} = g_{2a} + p_{2a} = 8.06 + 2.25 = 10.31 \ kN\backslash m'$$

Load For Moment.

$$g_{2e} = o.w. + C_e\, g_s\, L_c + C_e\, g_s \frac{L_c}{2}$$

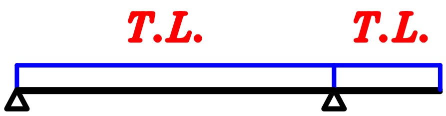
$$= 3.0 + (\tfrac{2}{3})(4.50)(1.5) + (\tfrac{1}{2})(4.50)(\tfrac{1.5}{2}) = 9.18 \ kN\backslash m'$$

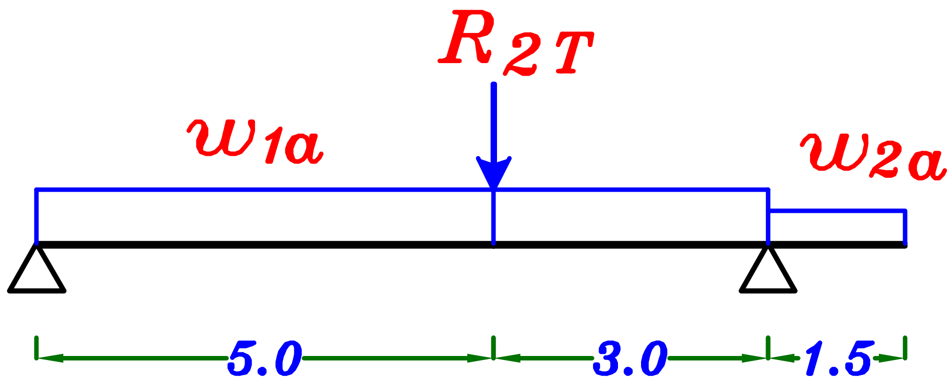
$$p_{2e} = C_e\, p_s\, L_c + C_e\, p_s \frac{L_c}{2}$$

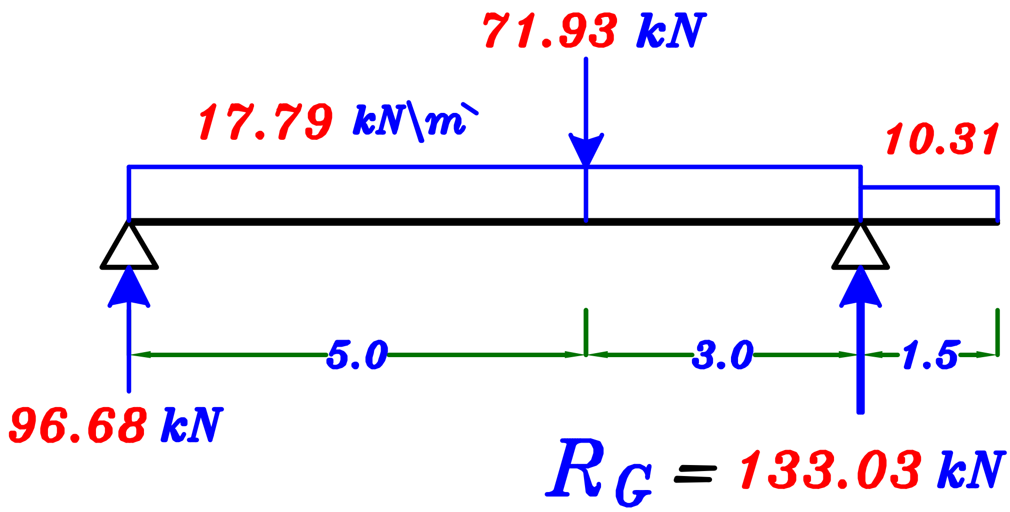
$$= (\tfrac{2}{3})(2.0)(1.5) + (\tfrac{1}{2})(2.0)(\tfrac{1.5}{2}) = 2.75 \ kN\backslash m'$$

$$w_{2e} = g_{2a} + p_{2a} = 9.18 + 2.75 = 11.93 \ kN\backslash m'$$

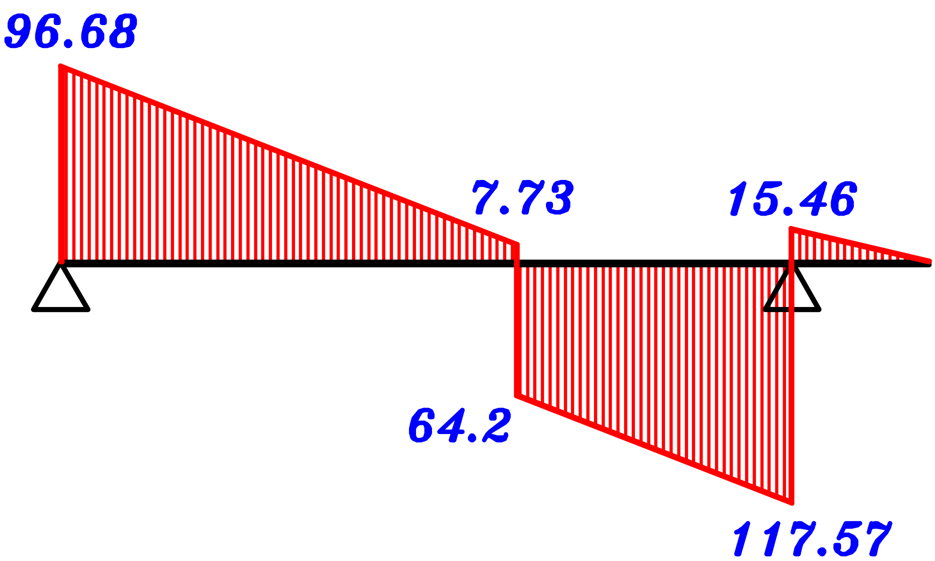
Draw the S.F.D.



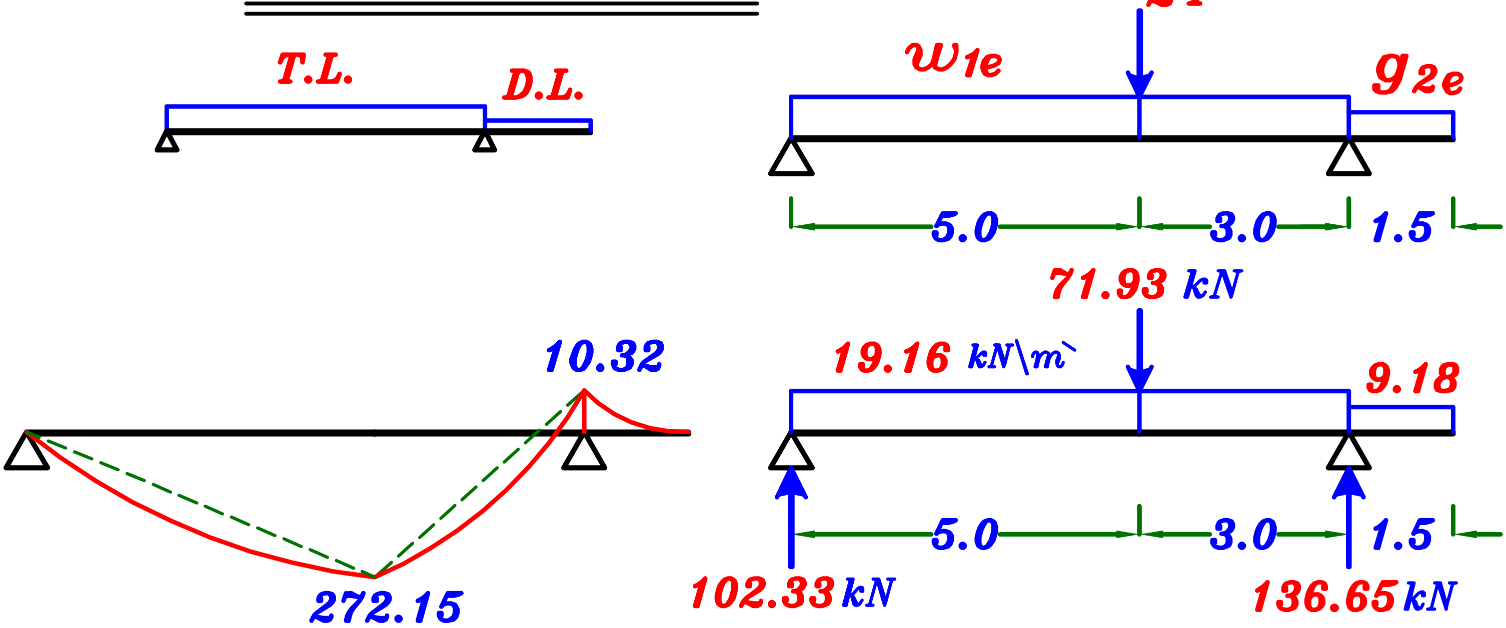




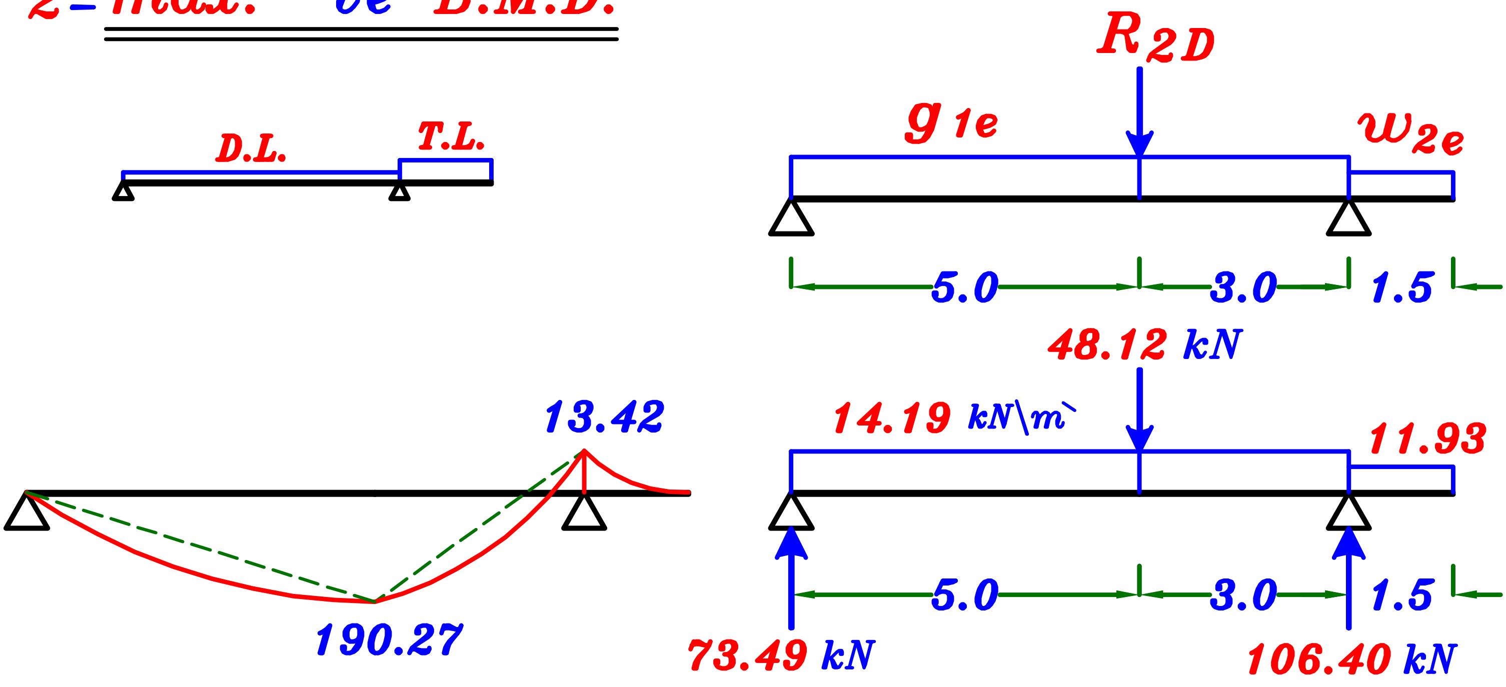
S.F.D.



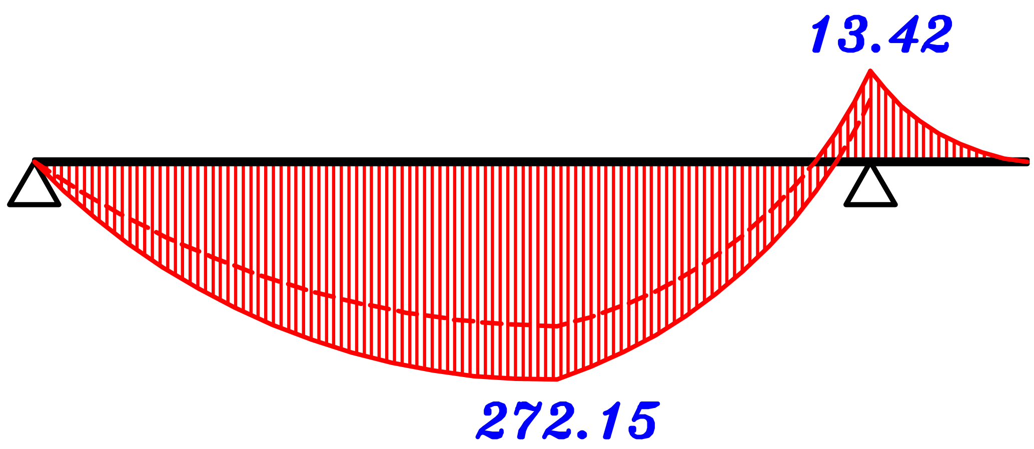
1- max. +ve B.M.D.



2- max. −ve B.M.D.



max.−max. B.M.D.



Example.

Data:

Slab thickness = 140 mm , F.C. = 3.0 kN/m^2 , L.L. = 1.0 kN/m^2

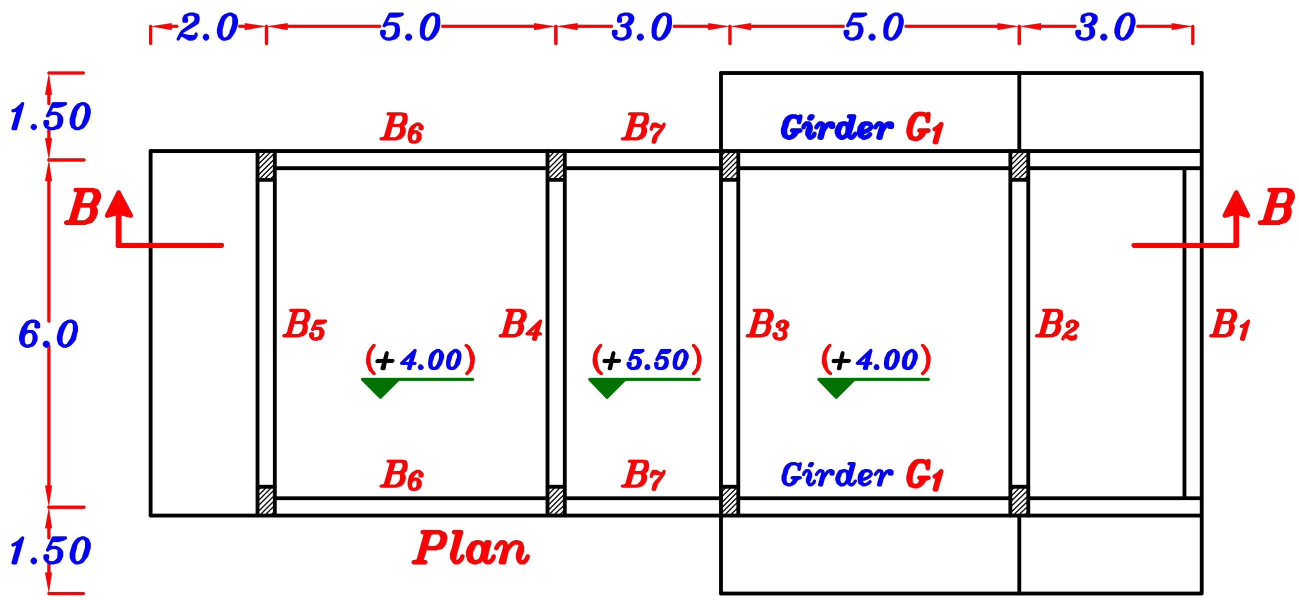
For the shown reinforced concrete building in the Figure It is required to :

1 – Draw to scale 1:50 a structural plan and section showing concrete dimensions of all structural elements.

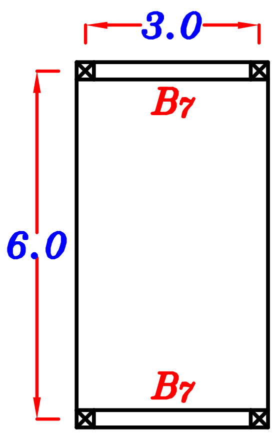
2 – Carry out load distribution For all beams at levels +4.00 and +5.50

3 – Calculate the loads For bending and shear For all beams and girder (G_1).

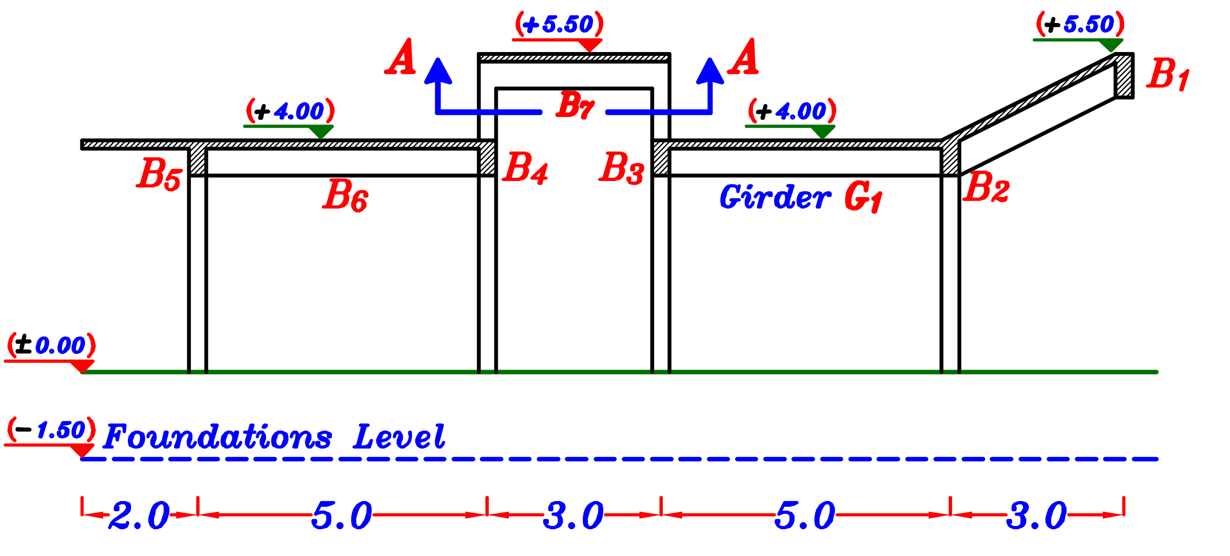
4 – Draw the absolute B.M.D. and S.F.D. For the girder (G_1).



Plan



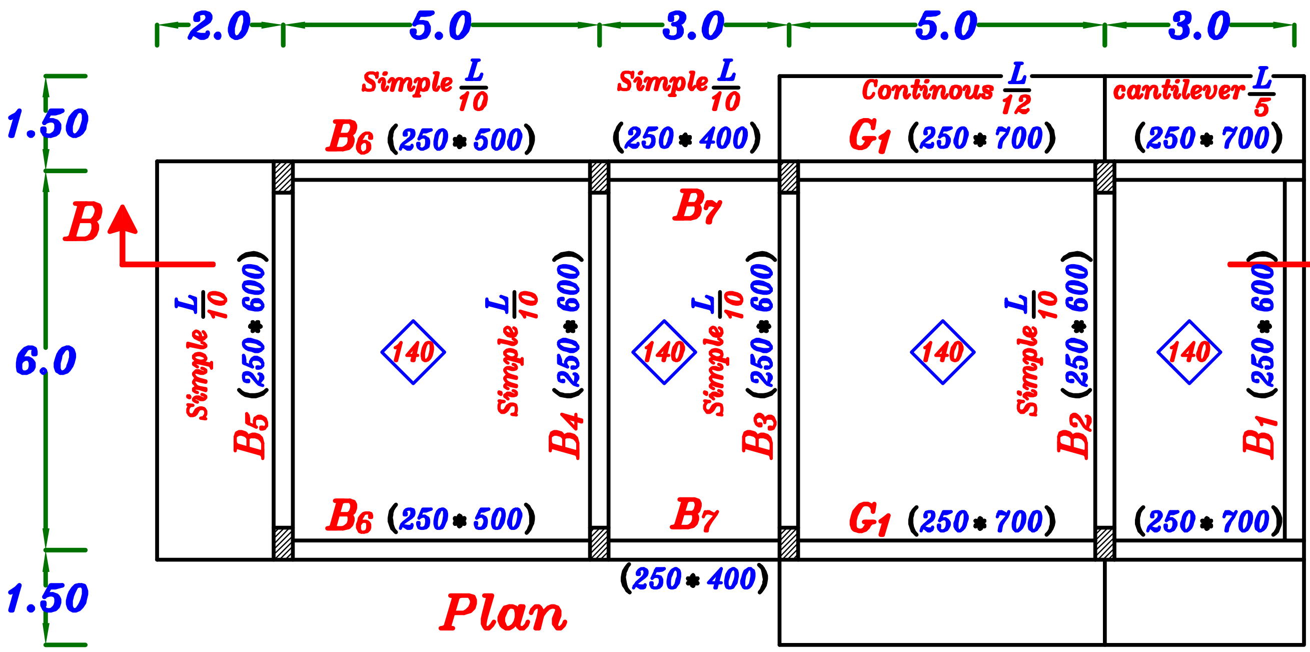
Sec. A–A



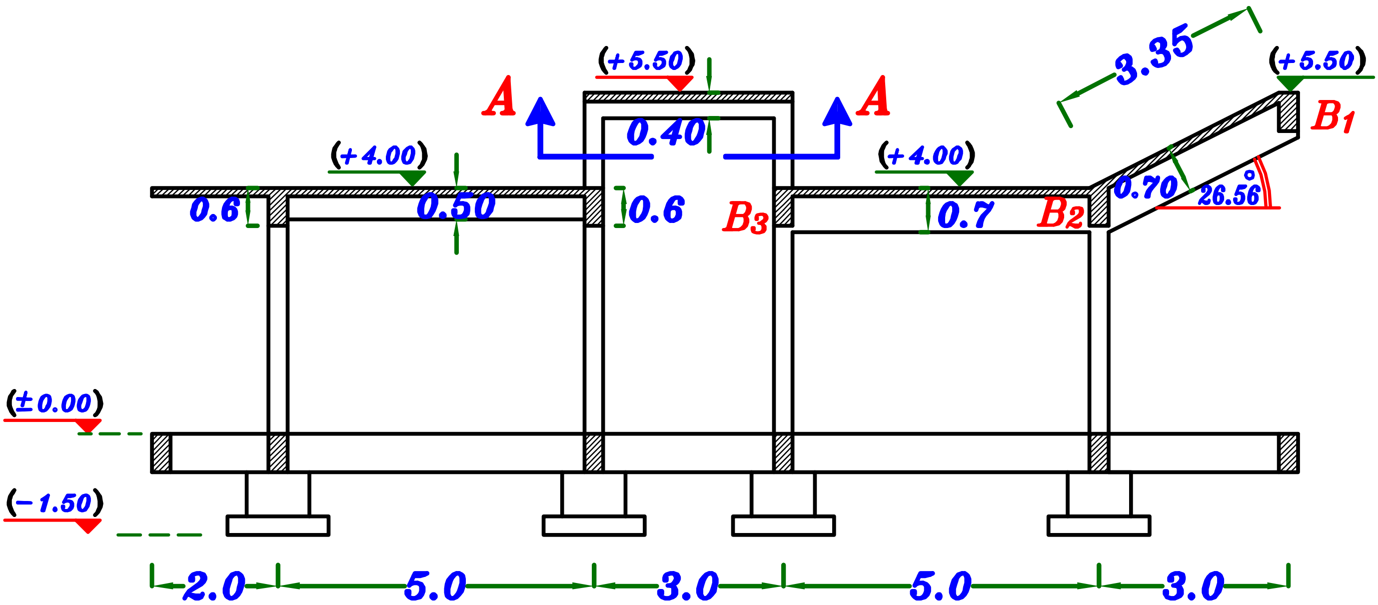
Sec. B–B

Solution.

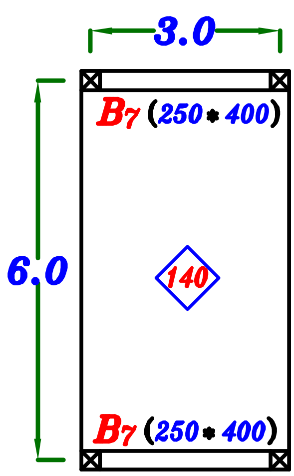
1 – Draw to scale 1:50 a structural plan and section showing concrete dimensions of all structural elements.



Plan

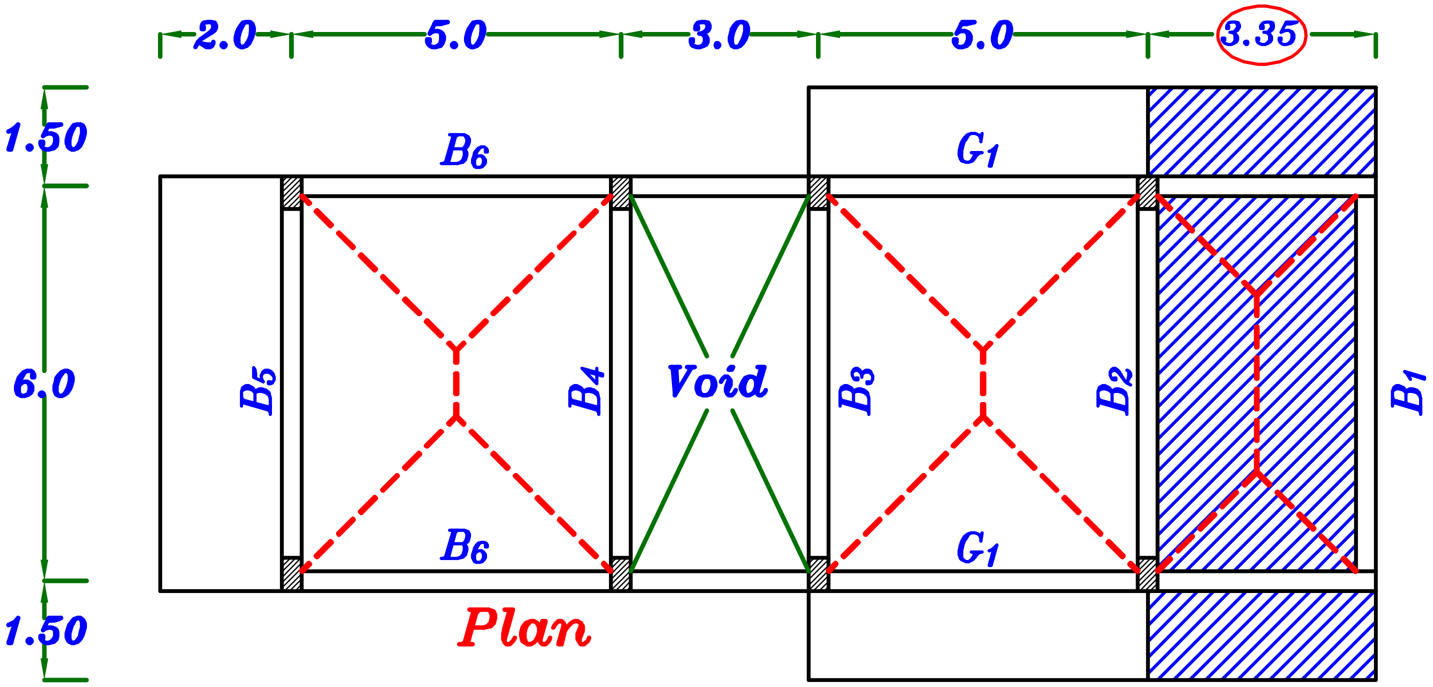


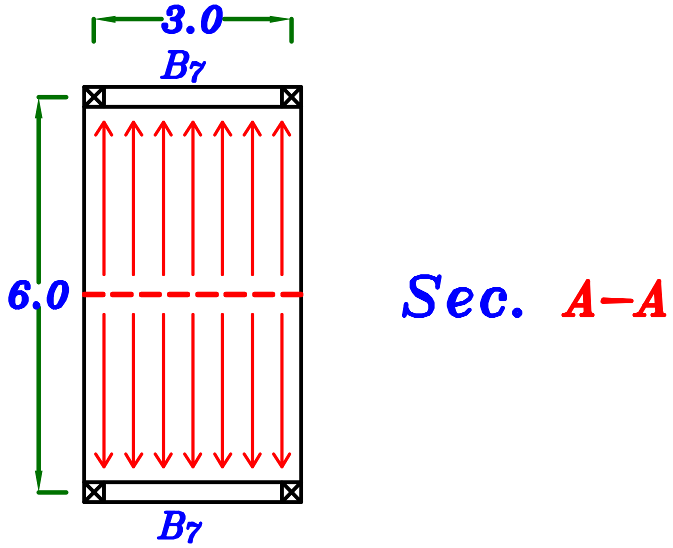
Sec. B–B



Sec. A–A

2- Carry out load distribution For all beams at levels +4.00 and +5.50





3- Calculate the loads For bending and shear For all beams and girder (G_1).

g_s, p_s

$$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 3.0 = 6.5 \ kN\backslash m^2$$

$$p_{sh} = L.L. = 1.0 \ kN\backslash m^2$$

$$p_{si} = L.L. * \cos\theta = 1.0 \ \cos 26.56 = 0.89 \ kN\backslash m^2$$

$\boxed{g_s = 6.5 \ kN\backslash m^2}$, $\boxed{p_{sh} = 1.0 \ kN\backslash m^2}$, $\boxed{p_{si} = 0.89 \ kN\backslash m^2}$

o.w. of Beams & Frames $= b\, t\, \gamma_c$

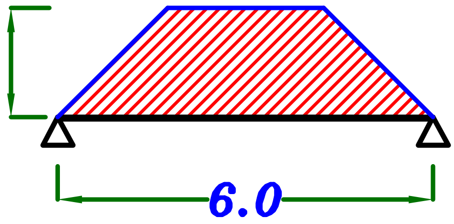
Beams	(250*400)	o.w. $= (0.25)(0.4)(25) =$	2.50 kN\m'
Beams	(250*500)	o.w. $= (0.25)(0.5)(25) =$	3.12 kN\m'
Beams	(250*600)	o.w. $= (0.25)(0.6)(25) =$	3.75 kN\m'
Girder	(250*700)	o.w. $= (0.25)(0.7)(25) =$	4.37 kN\m'

B_1 (250*600) $\longrightarrow$ o.w. $= 3.75$ kN\m'

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.35}{6.0}\right) = 0.72$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.35}{6.0}\right)^2 = 0.89$$



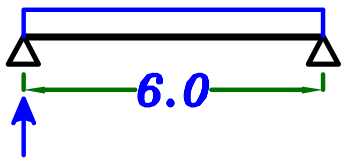
Load For Shear.

$$g_a = 0.W. + C_a\, g_s\, \frac{L_s}{2} = 3.75 + (0.72)(6.5)\left(\frac{3.35}{2}\right) = 11.59 \text{ kN\m'}$$

$$p_a = C_a\, p_{si}\, \frac{L_s}{2} = (0.72)(0.89)\left(\frac{3.35}{2}\right) = 1.07 \text{ kN\m'}$$

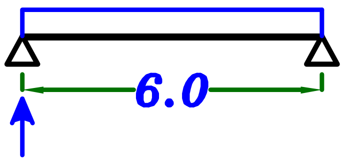
$$w_a = g_a + p_a = 11.59 + 1.07 = 12.66 \text{ kN\m'}$$

$w_a = 12.66$ kN\m'



$\boxed{R_{1T} = 37.98 \text{ kN}}$

$g_a = 11.59$ kN\m'



$\boxed{R_{1D} = 34.77 \text{ kN}}$

Load For Moment.

$$g_e = 0.W. + C_e\, g_s\, \frac{L_s}{2} = 3.75 + (0.89)(6.5)\left(\frac{3.35}{2}\right) = 13.44 \text{ kN\m'}$$

$$p_e = C_e\, p_{si}\, \frac{L_s}{2} = (0.89)(0.89)\left(\frac{3.35}{2}\right) = 1.32 \text{ kN\m'}$$

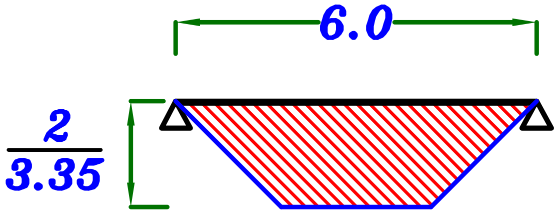
$$w_e = g_e + p_e = 13.44 + 1.32 = 14.76 \text{ kN\m'}$$

B_2 $\quad (250 * 600) \longrightarrow$ o.w. $= 3.75$ kN\m`

For Trapezoid 1

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.35}{6.0}\right) = 0.72$$

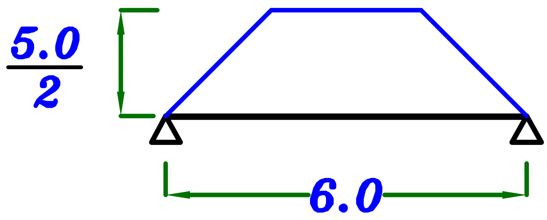
$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.35}{6.0}\right)^2 = 0.89$$



For Trapezoid 2

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5.0}{6.0}\right) = 0.58$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{5.0}{6.0}\right)^2 = 0.77$$



Load For Shear.

$$g_a = 0.W. + C_{a1}\, g_s \frac{L_s}{2} + C_{a2}\, g_s \frac{L_s}{2}$$

$$= 3.75 + (0.72)(6.5)\left(\frac{3.35}{2}\right) + (0.58)(6.5)\left(\frac{5.0}{2}\right) = 21.0 \text{ kN\m`}$$

$$p_a = C_{a1}\, p_{si} \frac{L_s}{2} + C_{a2}\, p_{sh} \frac{L_s}{2} =$$

$$= (0.72)(0.89)\left(\frac{3.35}{2}\right) + (0.58)(1.0)\left(\frac{5.0}{2}\right) = 2.52 \text{ kN\m`}$$

$$w_a = g_a + p_a = 21.0 + 2.52 = 23.52 \text{ kN\m`}$$

Load For Moment.

$$g_e = 0.W. + C_{e1}\, g_s \frac{L_s}{2} + C_{a2}\, g_s \frac{L_s}{2}$$

$$= 3.75 + (0.89)(6.5)\left(\frac{3.35}{2}\right) + (0.77)(6.5)\left(\frac{5.0}{2}\right) = 25.95 \text{ kN\m`}$$

$$p_e = C_{e1}\, p_{si} \frac{L_s}{2} + C_{a2}\, p_{sh} \frac{L_s}{2} =$$

$$= (0.89)(0.89)\left(\frac{3.35}{2}\right) + (0.77)(1.0)\left(\frac{5.0}{2}\right) = 3.25 \text{ kN\m`}$$

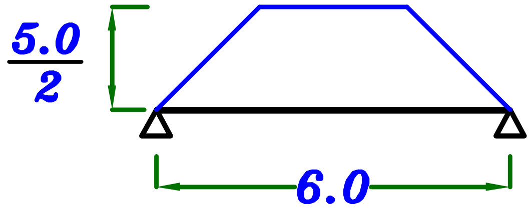
$$w_e = g_e + p_e = 25.95 + 3.25 = 29.20 \text{ kN\m`}$$

B_3 & B_4 (250*600) $\longrightarrow$ o.w. = 3.75 kN\m`

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5.0}{6.0}\right) = 0.58$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{5.0}{6.0}\right)^2 = 0.77$$



Load For Shear.

$$g_a = O.W. + C_a\, g_s\, \frac{L_s}{2} = 3.75 + (0.58)(6.5)\left(\frac{5.0}{2}\right) = 13.17 \text{ kN\m`}$$

$$p_a = C_a\, p_{sh}\, \frac{L_s}{2} = (0.58)(1.0)\left(\frac{5.0}{2}\right) = 1.45 \text{ kN\m`}$$

$$w_a = g_a + p_a = 13.17 + 1.45 = 14.62 \text{ kN\m`}$$

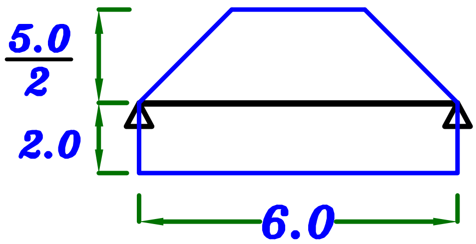
Load For Moment.

$$g_e = O.W. + C_e\, g_s\, \frac{L_s}{2} = 3.75 + (0.77)(6.5)\left(\frac{5.0}{2}\right) = 16.26 \text{ kN\m`}$$

$$p_e = C_e\, p_{sh}\, \frac{L_s}{2} = (0.77)(1.0)\left(\frac{5.0}{2}\right) = 1.92 \text{ kN\m`}$$

$$w_e = g_e + p_e = 16.26 + 1.92 = 18.18 \text{ kN\m`}$$

B_5 (250*600) $\longrightarrow$ o.w. = 3.75 kN\m`



For Trapezoid $C_a = 0.58$, $C_e = 0.77$

Load For Shear.

$$g_a = O.W. + C_a\, g_s\, \frac{L_s}{2} + g_s\, L_c = 3.75 + (0.58)(6.5)\left(\frac{5.0}{2}\right) + (6.5)(2.0) = 26.17 \text{ kN\m`}$$

$$p_a = C_a\, p_{sh}\, \frac{L_s}{2} + p_s\, L_c = (0.58)(1.0)\left(\frac{5.0}{2}\right) + (1.0)(2.0) = 3.45 \text{ kN\m`}$$

$$w_a = g_a + p_a = 26.17 + 3.45 = 29.62 \text{ kN\m`}$$

Load For Moment.

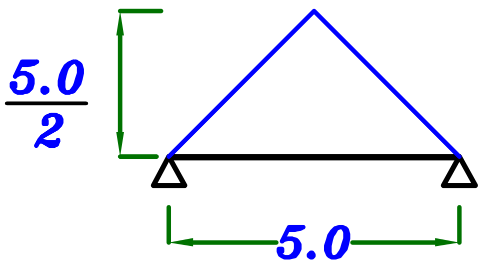
$$g_e = O.W. + C_e\, g_s\, \frac{L_s}{2} + g_s\, L_c = 3.75 + (0.77)(6.5)\left(\frac{5.0}{2}\right) + (6.5)(2.0) = 29.26 \text{ kN\m`}$$

$$p_e = C_e\, p_{sh}\, \frac{L_s}{2} + p_s\, L_c = (0.77)(1.0)\left(\frac{5.0}{2}\right) + (1.0)(2.0) = 3.92 \text{ kN\m`}$$

$$w_e = g_e + p_e = 29.26 + 3.92 = 33.18 \text{ kN\m`}$$

B_6 (250*500) → o.w. = 3.12 kN\m`

For Triangle $C_a = \frac{1}{2}$ $C_e = \frac{2}{3}$



Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} = 3.12 + \left(\frac{1}{2}\right)(6.5)\left(\frac{5.0}{2}\right) = 11.24 \text{ kN\m`}$$

$$p_a = C_a\, p_{sh} \frac{L_s}{2} = \left(\frac{1}{2}\right)(1.0)\left(\frac{5.0}{2}\right) = 1.25 \text{ kN\m`}$$

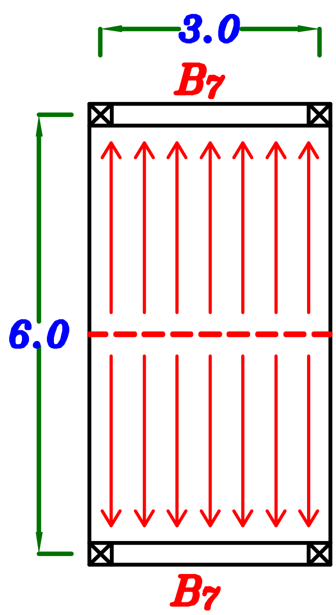
$$w_a = g_a + p_a = 11.24 + 1.25 = 12.49 \text{ kN\m`}$$

Load For Moment.

$$g_e = O.W. + C_e\, g_s \frac{L_s}{2} = 3.12 + \left(\frac{2}{3}\right)(6.5)\left(\frac{5.0}{2}\right) = 13.95 \text{ kN\m`}$$

$$p_e = C_e\, p_{sh} \frac{L_s}{2} = \left(\frac{2}{3}\right)(1.0)\left(\frac{5.0}{2}\right) = 1.67 \text{ kN\m`}$$

$$w_e = g_e + p_e = 13.95 + 1.67 = 15.62 \text{ kN\m`}$$



B_7 (250*400) → o.w. = 2.50 kN\m`

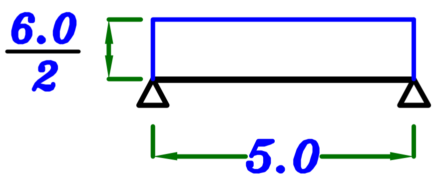
Load For Shear. = Load For Moment.

$$g_a = g_e = O.W. + g_s \frac{L_s}{2}$$

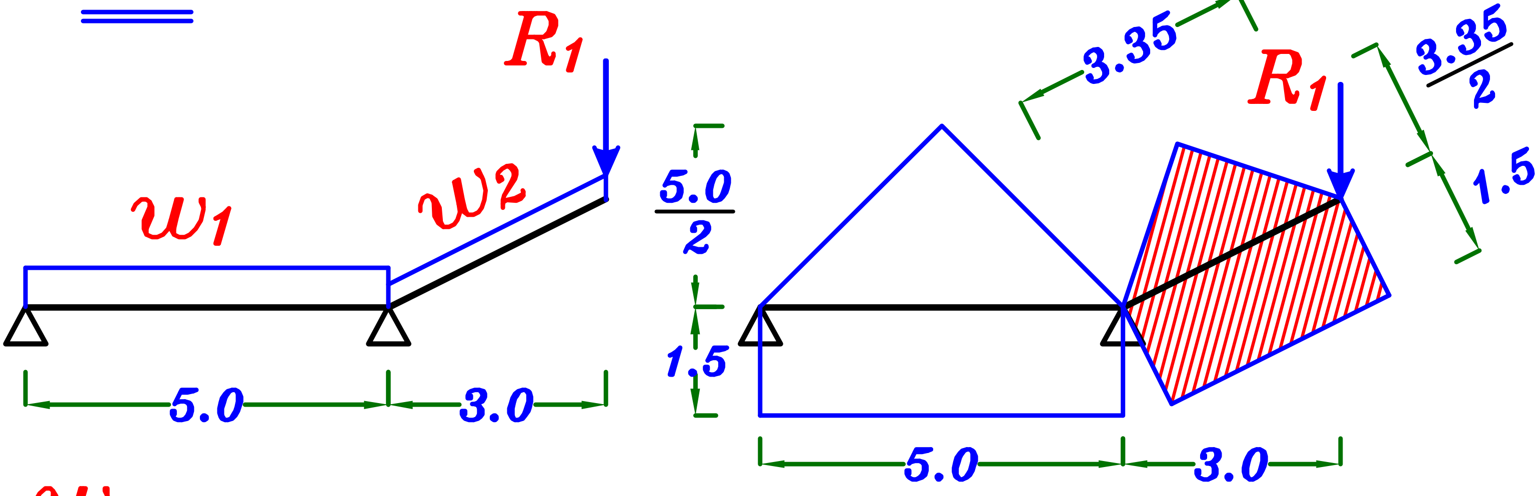
$$= 2.50 + (6.5)\left(\frac{6.0}{2}\right) = 22.0 \text{ kN\m`}$$

$$p_a = p_e = p_{sh} \frac{L_s}{2} = (1.0)\left(\frac{6.0}{2}\right) = 3.0 \text{ kN\m`}$$

$$w_a = g_a + p_a = 22.0 + 3.0 = 25.0 \text{ kN\m`}$$



G_1 (250*700) $\longrightarrow$ o.w. = 4.37 kN\m



W_1 For triangle $C_a = \frac{1}{2}$ $C_e = \frac{2}{3}$

Load For Shear.

$$g_{1a} = o.w. + C_a\, g_s\, \frac{L_s}{2} + g_s\, L_c = 4.37 + (\tfrac{1}{2})(6.5)(\tfrac{5.0}{2}) + (6.5)(1.5) = 22.25 \text{ kN\textbackslash m}$$

$$p_{1a} = C_a\, p_{sh}\, \frac{L_s}{2} + p_{sh}\, L_c = (\tfrac{1}{2})(1.0)(\tfrac{5.0}{2}) + (1.0)(1.5) = 2.75 \text{ kN\textbackslash m}$$

$$w_{1a} = g_{1a} + p_{1a} = 22.25 + 2.75 = 25.0 \text{ kN\textbackslash m}$$

Load For Moment.

$$g_{1e} = o.w. + C_e\, g_s\, \frac{L_s}{2} + g_s\, L_c = 4.37 + (\tfrac{2}{3})(6.5)(\tfrac{5.0}{2}) + (6.5)(1.5) = 24.95 \text{ kN\textbackslash m}$$

$$p_{1e} = C_e\, p_{sh}\, \frac{L_s}{2} + p_{sh}\, L_c = (\tfrac{2}{3})(1.0)(\tfrac{5.0}{2}) + (1.0)(1.5) = 3.16 \text{ kN\textbackslash m}$$

$$w_{1e} = g_{1e} + p_{1e} = 24.95 + 3.16 = 28.11 \text{ kN\textbackslash m}$$

W_2 For triangle $C_a = \frac{1}{2}$ $C_e = \frac{1}{2}$

Load For Shear. = Load For Moment.

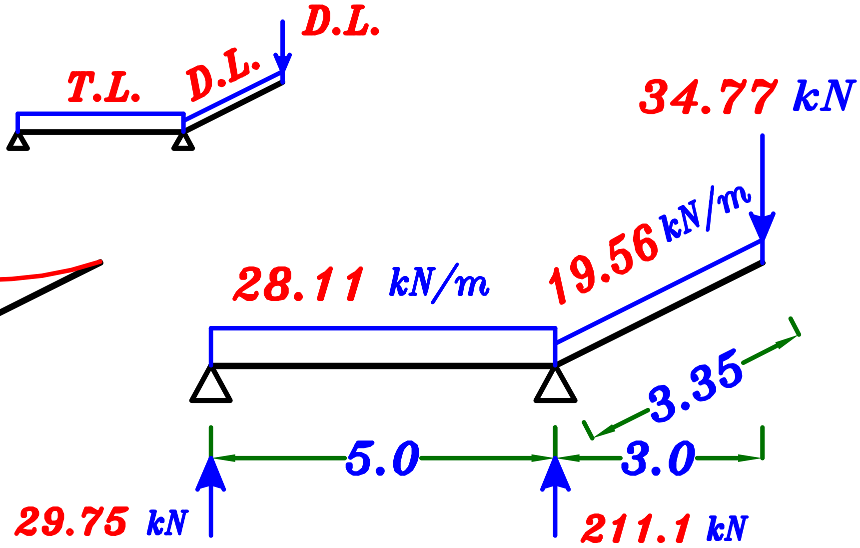
$$g_{2a} = g_{2e} = o.w. + C_a\, g_s\, \frac{L_c}{2} + g_s\, L_c = 4.37 + (\tfrac{1}{2})(6.5)(\tfrac{3.35}{2}) + (6.5)(1.5) = 19.56 \text{ kN\textbackslash m}$$

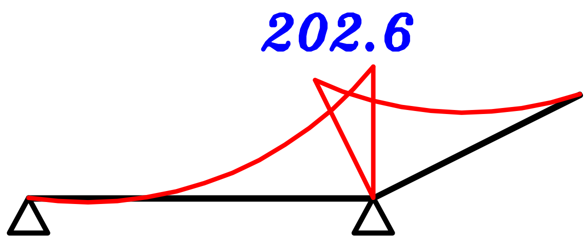
$$p_{2a} = p_{2e} = C_a\, p_{si}\, \frac{L_c}{2} + p_{si}\, L_c = (\tfrac{1}{2})(0.89)(\tfrac{3.35}{2}) + (0.89)(1.5) = 2.08 \text{ kN\textbackslash m}$$

$$w_{2a} = w_{2e} = g_{2a} + p_{2a} = 19.56 + 2.08 = 21.64 \text{ kN\textbackslash m}$$

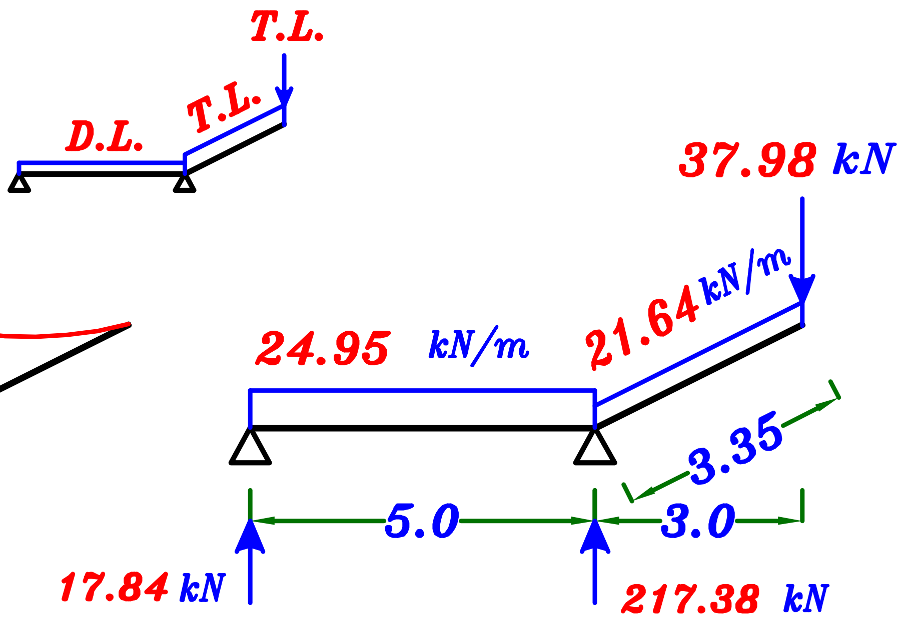
4- Draw the absolute B.M.D. and S.F.D. For the girder (G_1).

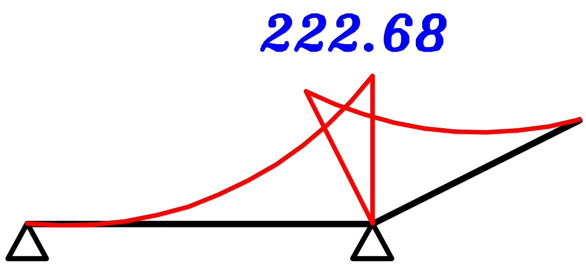
(max. +ve) B.M.D.



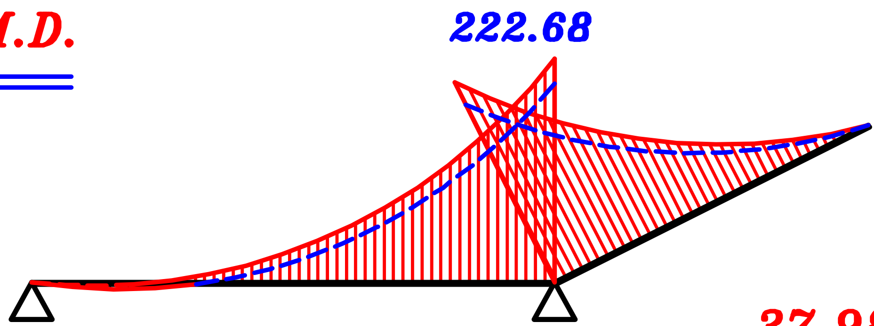


(max. -ve) B.M.D.

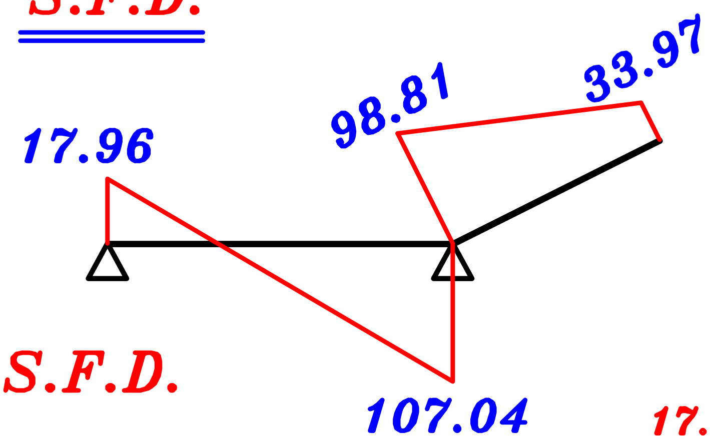


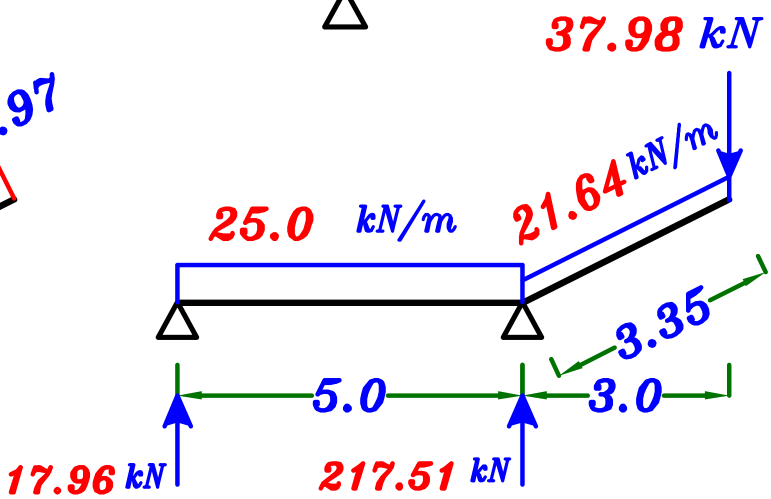


(max-max) B.M.D.

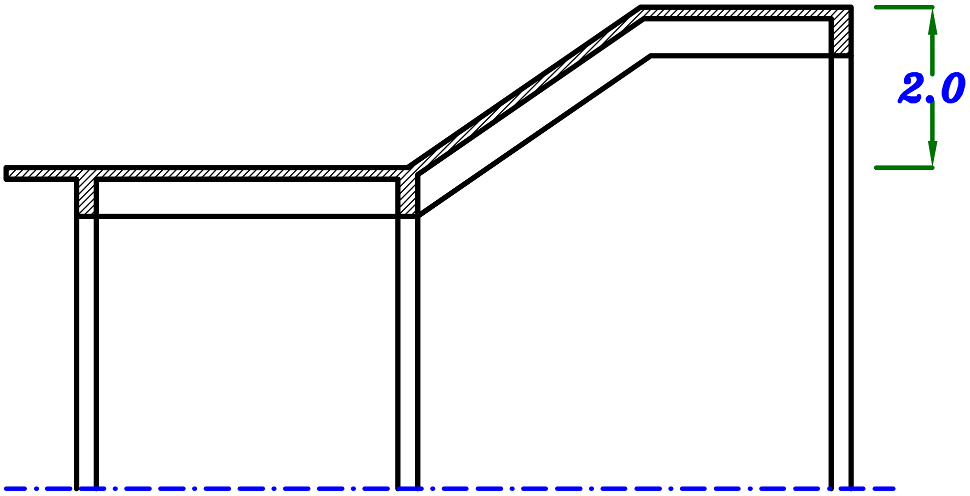


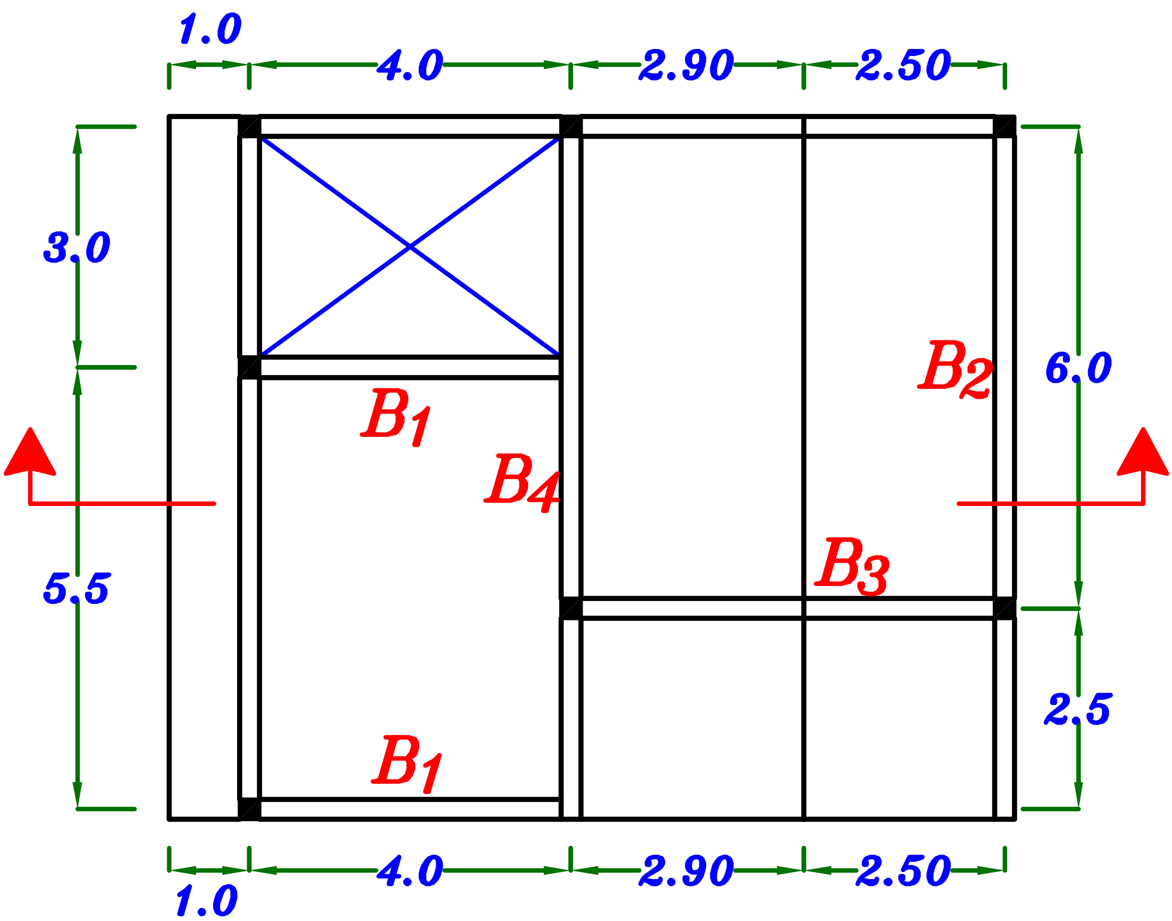
S.F.D.





Example.



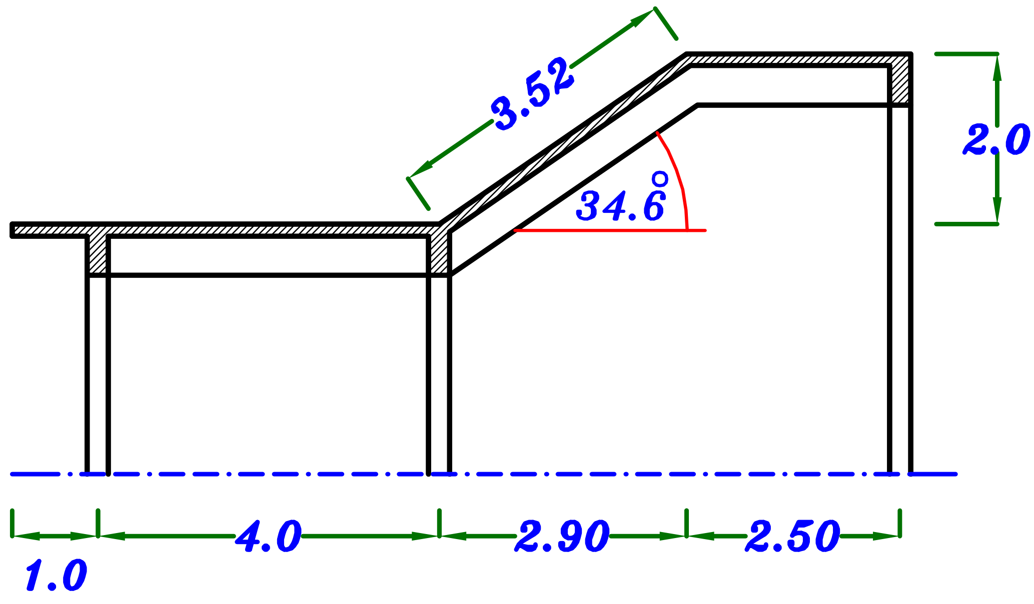


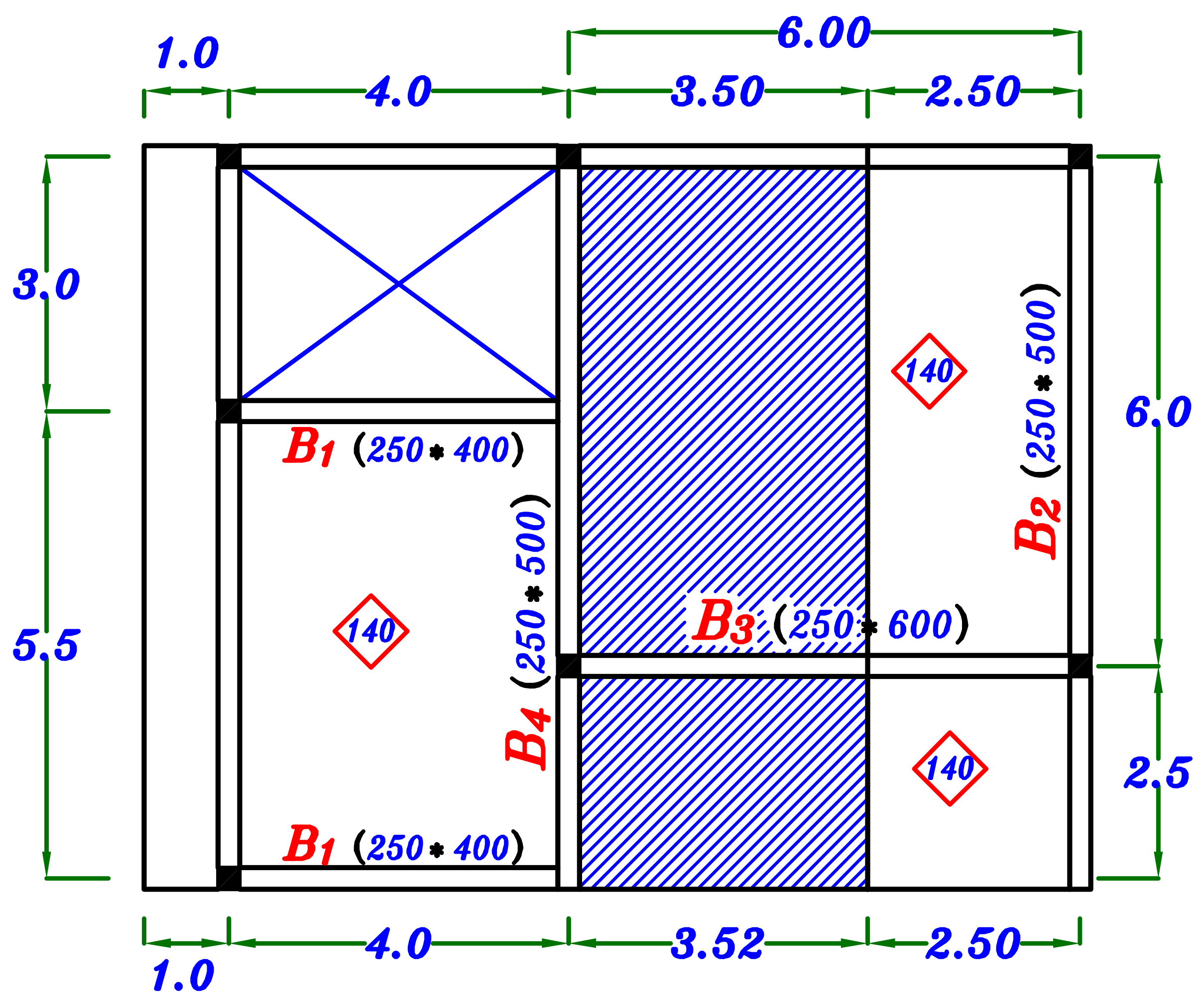
Data:

- Slab thickness $t_s = 140$ mm
- Live load = 2.0 kN\m² HL. projection.
- Floor cover = 1.50 kN\m²

Required:

Draw max–max B.M.D. For Beams (B_2 , B_3 & B_4)





o.w. of Beams & Frames $= b\ t\ \gamma_c$

Beams (250*400) o.w. $= (0.25)(0.4)(25) = 2.50$ kN\m`

Beams (250*500) o.w. $= (0.25)(0.5)(25) = 3.12$ kN\m`

Beams (250*600) o.w. $= (0.25)(0.6)(25) = 3.75$ kN\m`

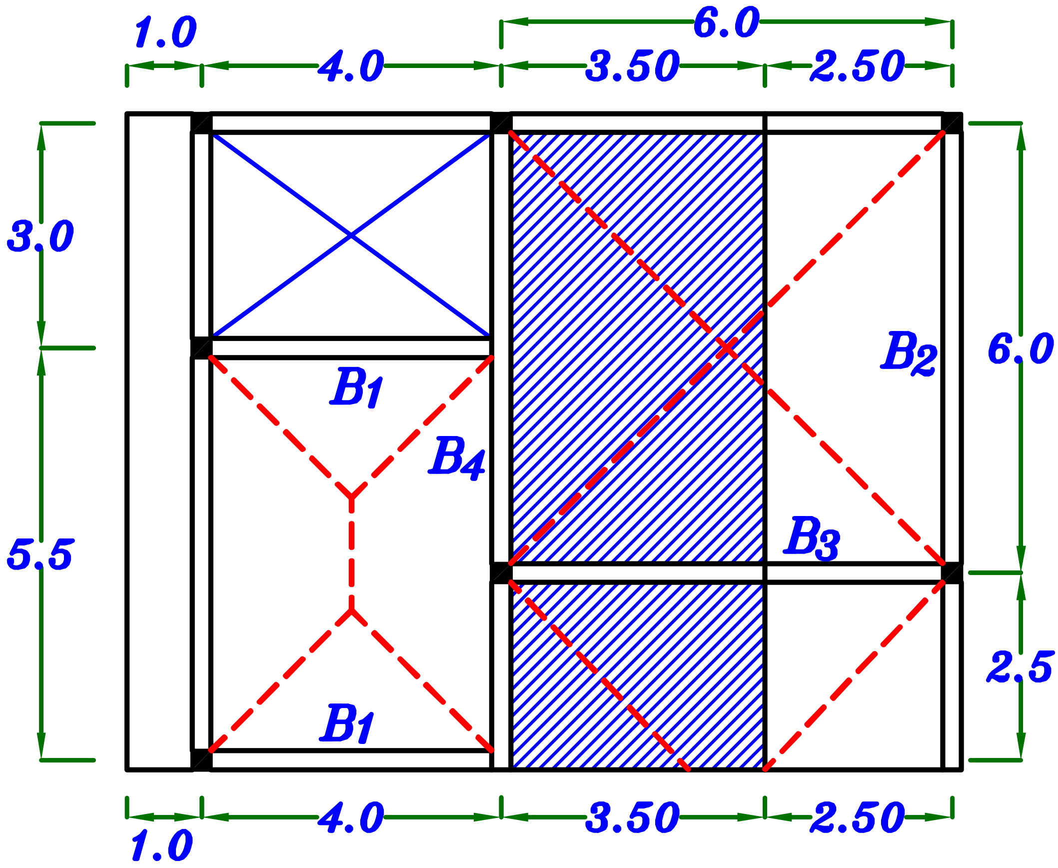
g_s , p_s

$$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 1.5 = 5.0 \ kN\backslash m^2$$

$$p_{sh} = L.L. = 2.0 \ kN\backslash m^2$$

$$p_{si} = L.L. * Cos\,\theta = 2.0 \ Cos\ 34.6 = 1.64 \ kN\backslash m^2$$

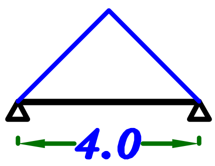
$\boxed{g_s = 5.0 \ kN\backslash m^2}$, $\boxed{p_{sh} = 2.0 \ kN\backslash m^2}$, $\boxed{p_{si} = 1.64 \ kN\backslash m^2}$



B_1

$(250*400) \longrightarrow o.w. = 2.50 \ kN\backslash m`$

Triangle $C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$

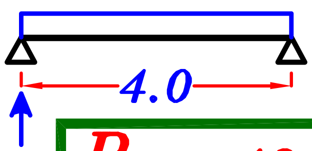


$$g_a = o.w. + C_a \ g_s \ \frac{L_s}{2} = 2.50 + \frac{1}{2}(5.0)\left(\frac{4.0}{2}\right) = 7.50 \ kN\backslash m`$$

$$p_a = C_a \ p_{sh} \frac{L_s}{2} = \frac{1}{2}(2.0)\left(\frac{4.0}{2}\right) = 2.0 \ kN\backslash m`$$

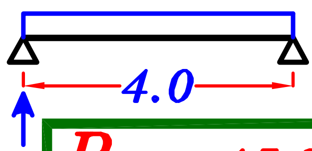
$$w_a = g_a + p_a = 7.50 + 2.0 = 9.50 \ kN\backslash m`$$

$w_a = 9.50 \ kN\backslash m`$



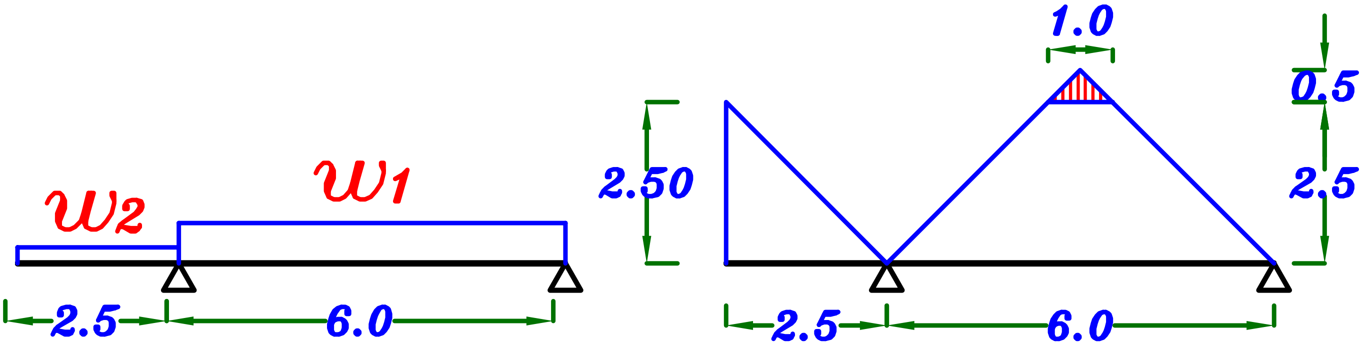
$\boxed{R_{1T} = 19.0 \ kN}$

$g_a = 7.50 \ kN\backslash m`$

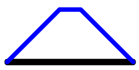


$\boxed{R_{1D} = 15.0 \ kN}$

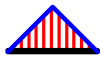
B_2 (250*500) ⟶ $o.w. = 3.12$ kN\m`



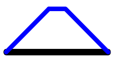
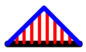
w_1 For Trapezoid



For Trapezoid $\dfrac{\sum area}{span} = \dfrac{(\frac{6+1}{2})(2.5)}{6.0} = 1.458$



For Triangle $\dfrac{\sum area}{span} = \dfrac{0.5\,(1.0)\,(0.5)}{6.0} = 0.0416$

$$g_{1e} = o.w. + \frac{\sum area}{span} * g_s + \frac{\sum area}{span} * g_s$$

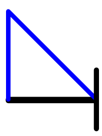
$$= 3.12 + (1.458)(5.0) + (0.0416)(5.0) = 10.618 \text{ kN\m`}$$

$$p_{1e} = \frac{\sum area}{span} * p_{sh} + \frac{\sum area}{span} * p_{si}$$

$$= (1.458)(2.0) + (0.0416)(1.64) = 2.984 \text{ kN\m`}$$

$$w_{1e} = g_{1e} + p_{1e} = 10.618 + 2.984 = 13.60 \text{ kN\m`}$$

w_2 For Triangle



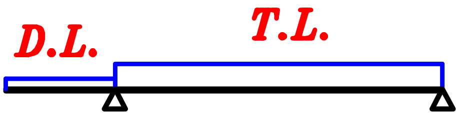
$C_e = \dfrac{2}{3}$

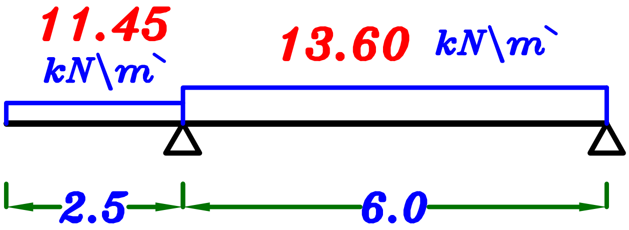
$$g_{2e} = o.w. + C_e\, g_s\, L_c = 3.12 + (\tfrac{2}{3})(5.0)(2.5) = 11.45 \text{ kN\m`}$$

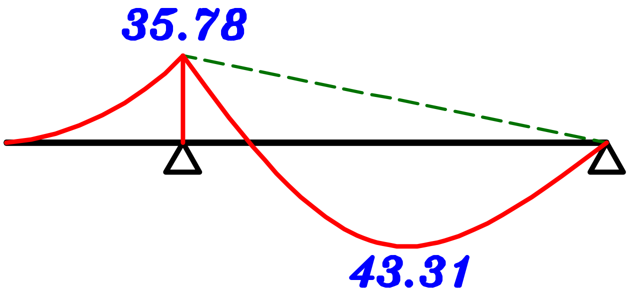
$$p_{2e} = C_e\, p_{sh}\, L_c = (\tfrac{2}{3})(2.0)(2.5) = 3.33 \text{ kN\m`}$$

$$w_{2e} = g_{2e} + p_{2e} = 11.45 + 3.33 = 14.78 \text{ kN\m`}$$

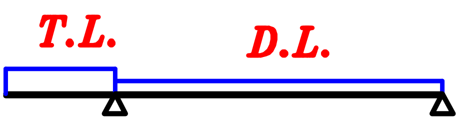
1- max. +Ve B.M.D.

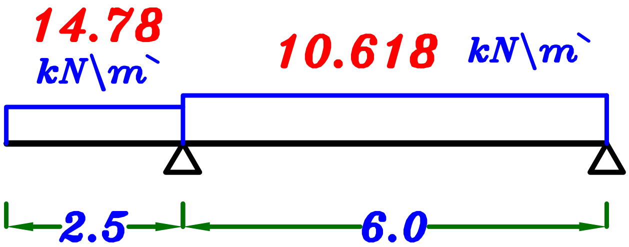


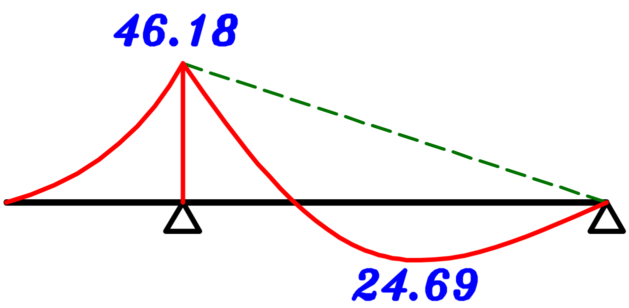




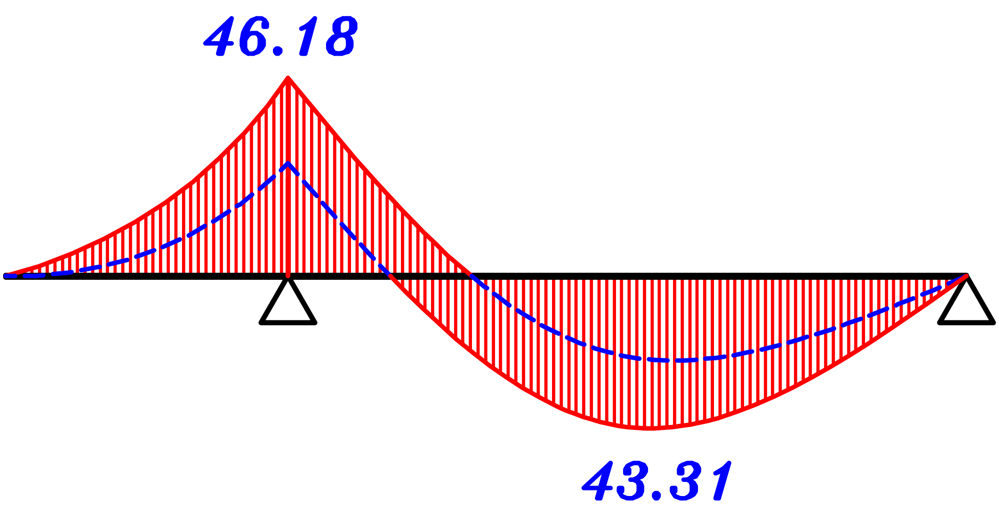
2- max. -Ve B.M.D.



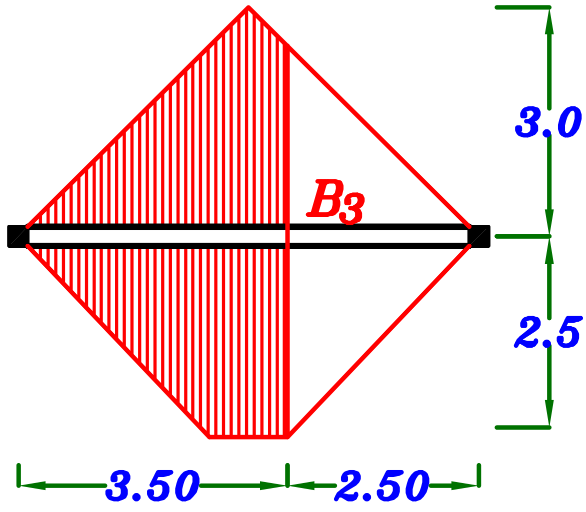


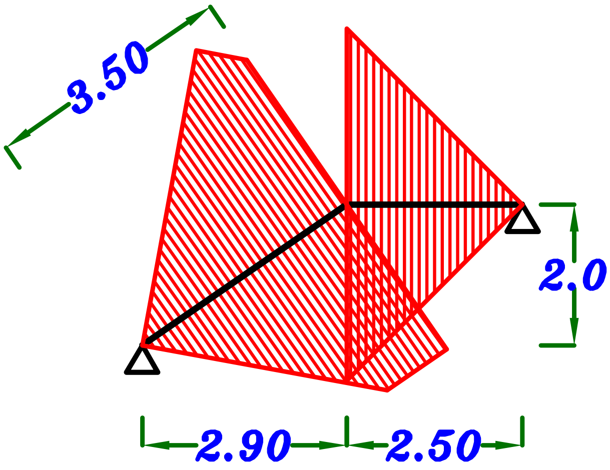


max.-max. B.M.D. B_2



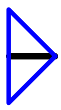
B_3 (250*600) → o.w. = 3.75 kN\m`

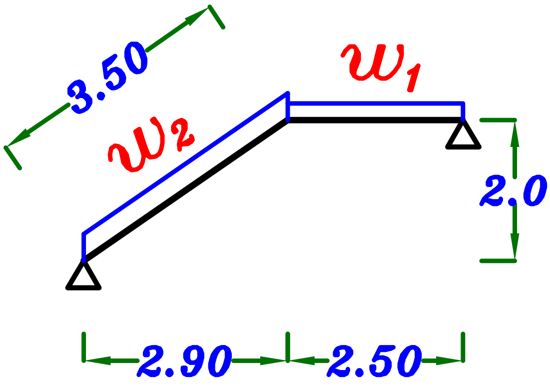




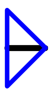
w_1

For Triangle





$$\frac{\sum area}{span} = \frac{2\,(0.5)(2.5)(2.5)}{2.50} = 2.50$$

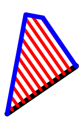


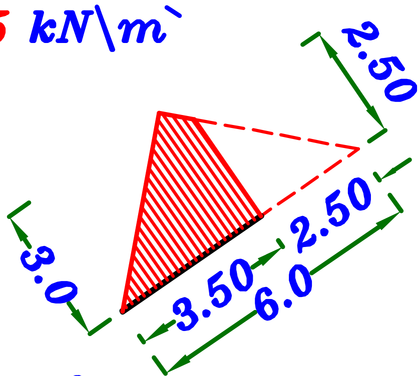
$$g_{1e} = o.w. + \frac{\sum area}{span} * g_s = 3.75 + (2.50)(5.0) = 16.25 \text{ kN\m`}$$

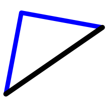
$$p_{1e} = \frac{\sum area}{span} * p_{sh} = (2.50)(2.0) = 5.0 \text{ kN\m`}$$

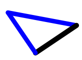
$$w_{1e} = g_{1e} + p_{1e} = 16.25 + 5.0 = 21.25 \text{ kN\m`}$$

w_2

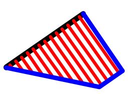
For area 

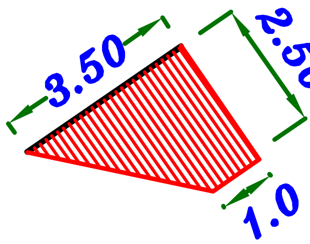




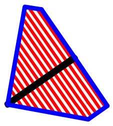


$$area = (0.5)(6.0)(3.0) - (0.5)(2.5)(2.5) = 5.875 \text{ m}^2$$

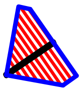
For area 



$$\left(\frac{3.50 + 2.5}{2.0}\right)(1.0) = 5.625 \text{ m}^2$$



$$\frac{\sum area}{span} = \frac{5.875 + 5.625}{3.50} = 3.29$$

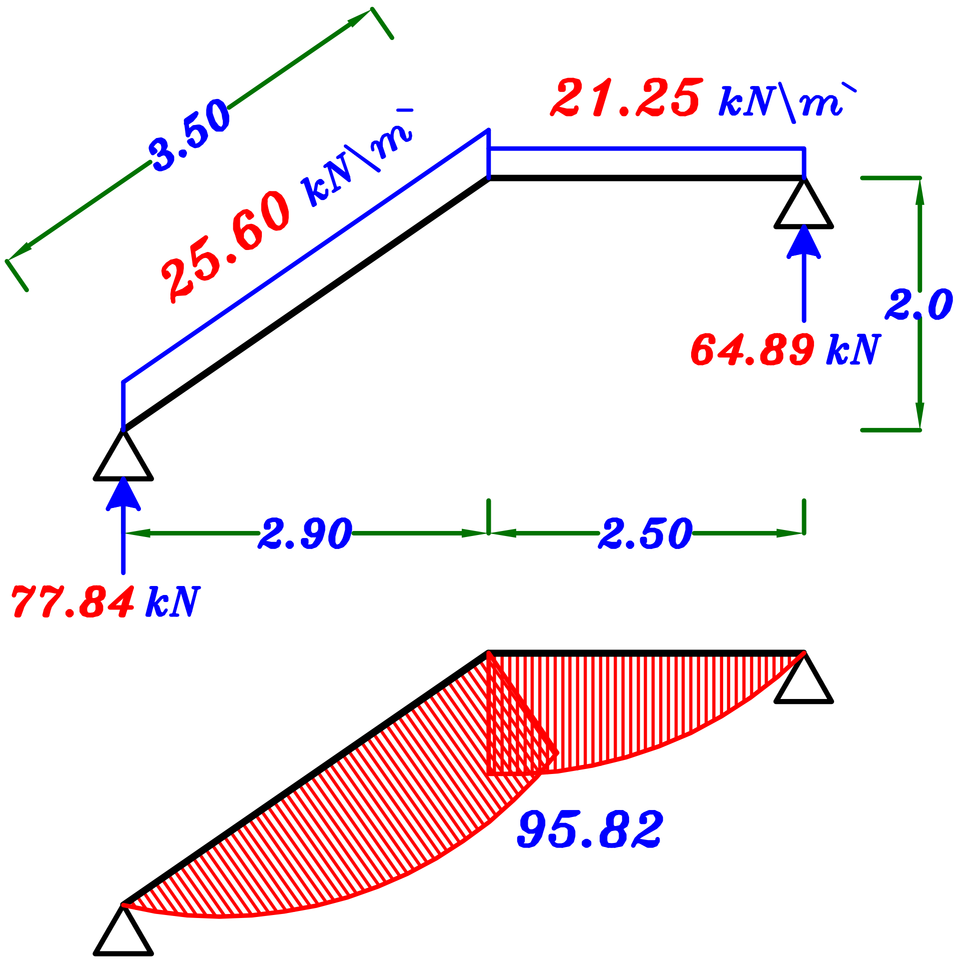


$$g_{2e} = o.w. + \frac{\sum area}{span} * g_s = 3.75 + (3.29)(5.0) = 20.20 \ kN\backslash m`$$

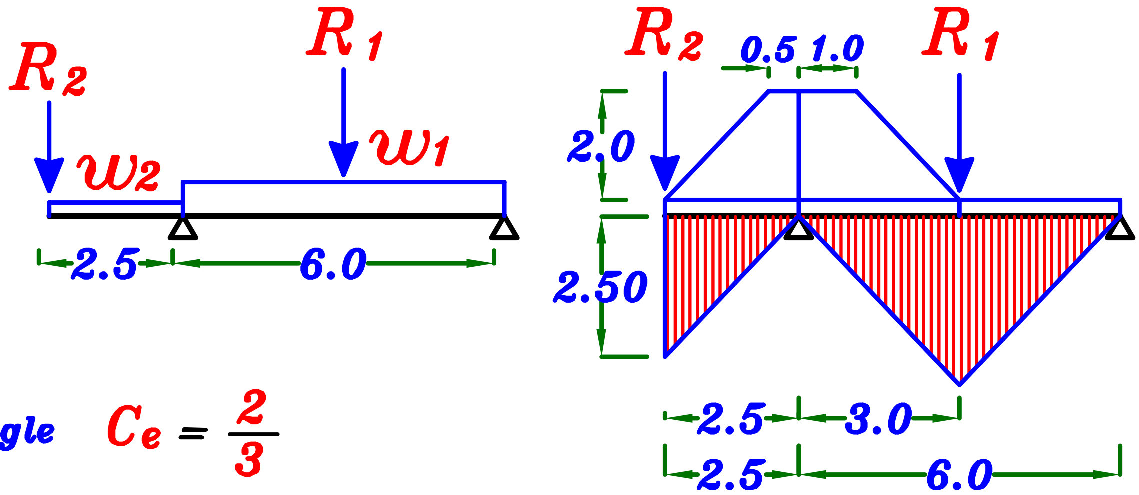
$$p_{2e} = \frac{\sum area}{span} * p_{si} = (3.29)(1.64) = 5.40 \ kN\backslash m`$$

$$w_{2e} = g_{2e} + p_{2e} = 20.20 + 5.40 = 25.60 \ kN\backslash m`$$

max.–max. B.M.D. B_3



B_4 (250*500) → o.w. = 3.12 kN\m`



w_1

For Triangle $C_e = \frac{2}{3}$

For Trapezoid $\frac{\sum area}{span} = \frac{\left(\frac{3.0+1.0}{2.0}\right)(2.0)}{6.0} = 0.67$

$$g_{1e} = o.w. + C_e\, g_s \frac{L_s}{2} + \frac{\sum area}{span} * g_s$$

$$= 3.12 + \left(\frac{2}{3}\right)(5.0)(3.0) + (0.67)(5.0) = 16.47 \text{ kN\m`}$$

$$p_{1e} = C_e\, p_{si} \frac{L_s}{2} + \frac{\sum area}{span} * p_{sh}$$

$$= \left(\frac{2}{3}\right)(1.64)(3.0) + (0.67)(2.0) = 4.62 \text{ kN\m`}$$

$$w_{1e} = g_{1e} + p_{1e} = 16.47 + 4.62 = 21.09 \text{ kN\m`}$$

w_2

For Triangle $C_e = \frac{2}{3}$

For Trapezoid $\frac{\sum area}{span} = \frac{\left(\frac{2.5+0.5}{2.0}\right)(2.0)}{2.5} = 1.20$

$$g_{2e} = o.w. + C_e\, g_s L_c + \frac{\sum area}{span} * g_s$$

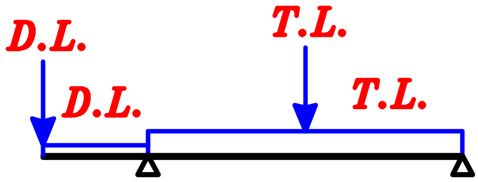
$$= 3.12 + \left(\frac{2}{3}\right)(5.0)(2.5) + (1.20)(5.0) = 17.45 \text{ kN\m`}$$

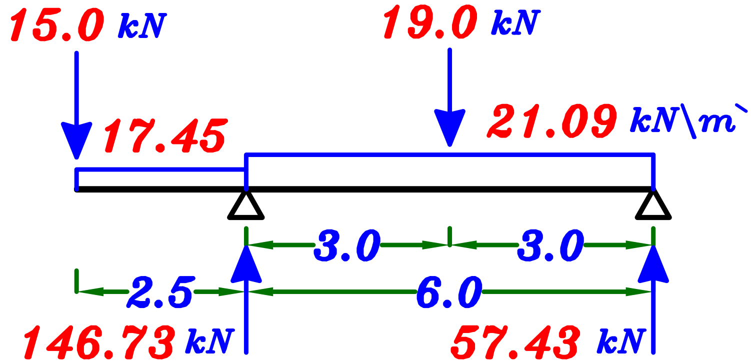
$$p_{2e} = C_e\, p_{si} L_c + \frac{\sum area}{span} * p_{sh}$$

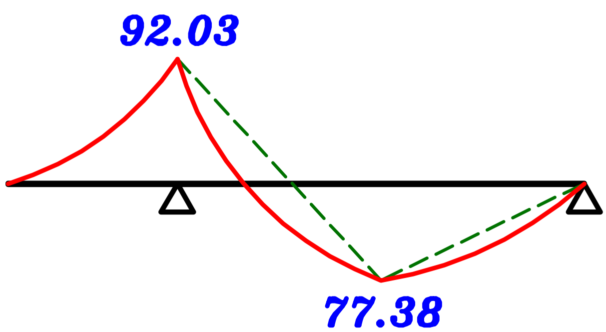
$$= \left(\frac{2}{3}\right)(1.64)(2.5) + (1.20)(2.0) = 5.13 \text{ kN\m`}$$

$$w_{2e} = g_{2e} + p_{2e} = 17.45 + 5.13 = 22.58 \text{ kN\m`}$$

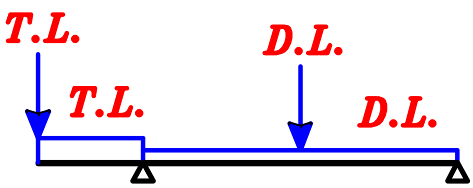
1- max. +ve B.M.D.

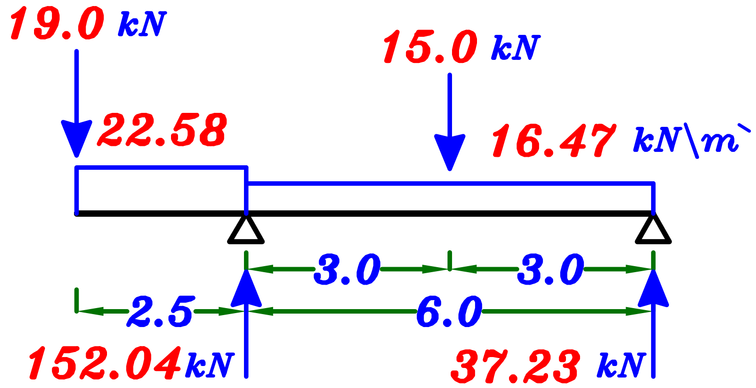


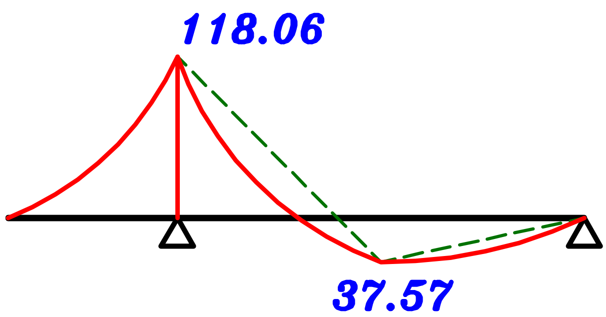




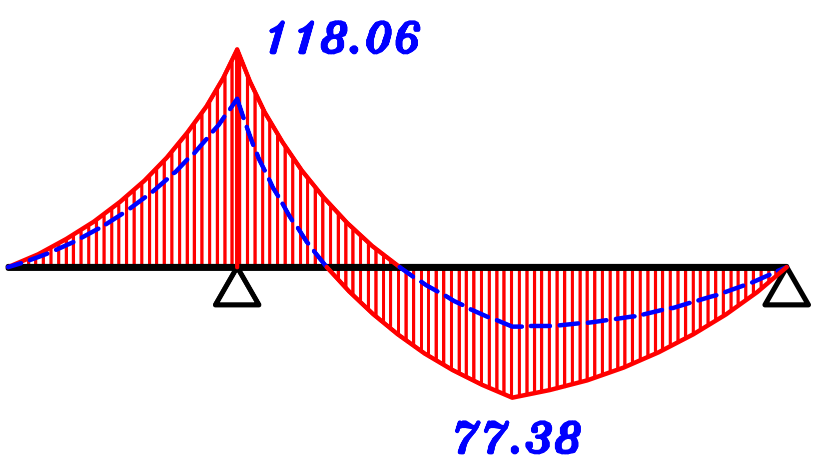
2- max. −ve B.M.D.







max.−max. B.M.D. B_4



Example.

The Figure shows a sectional elevation of a reinforced concrete roof. The roof is covered by reinforced concrete slabs supported by a system of secondary beams and Frames (F) spaced at 5.0 m. For an intermediate panel, it is required to :

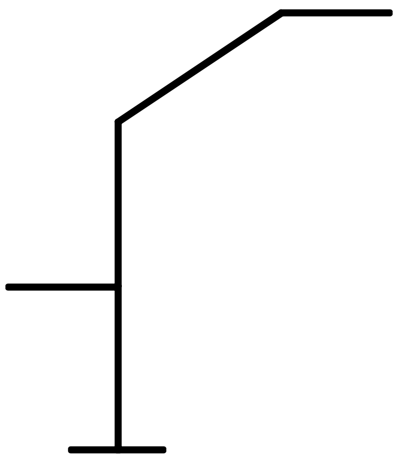
1 – Draw a structural plan showing the pattern of load distribution.

2 – Calculate the equivalent working loads for shear and moment For all secondary beams (B_1 , B_2 , B_3 & B_4) and an intermediate Frame (F) .

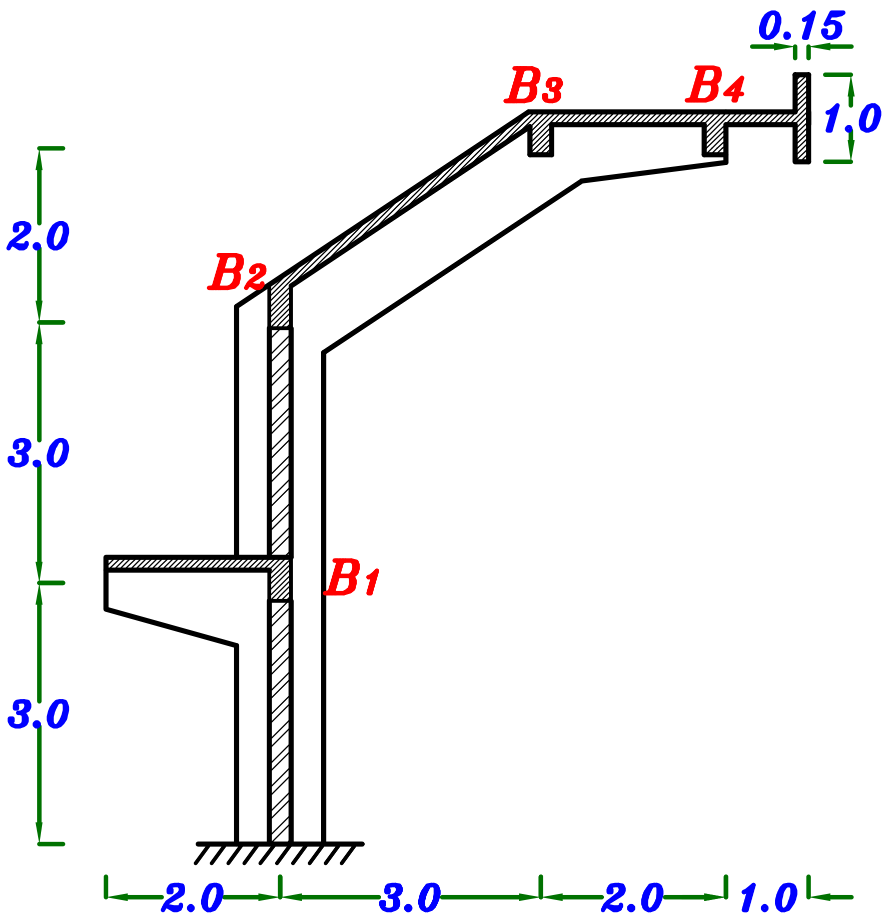
3 – Draw the N.F.D. (total load) , S.F.D. (total load) and max–max B.M.D. For an intermediate Frame (F) , using ultimate limit loads.

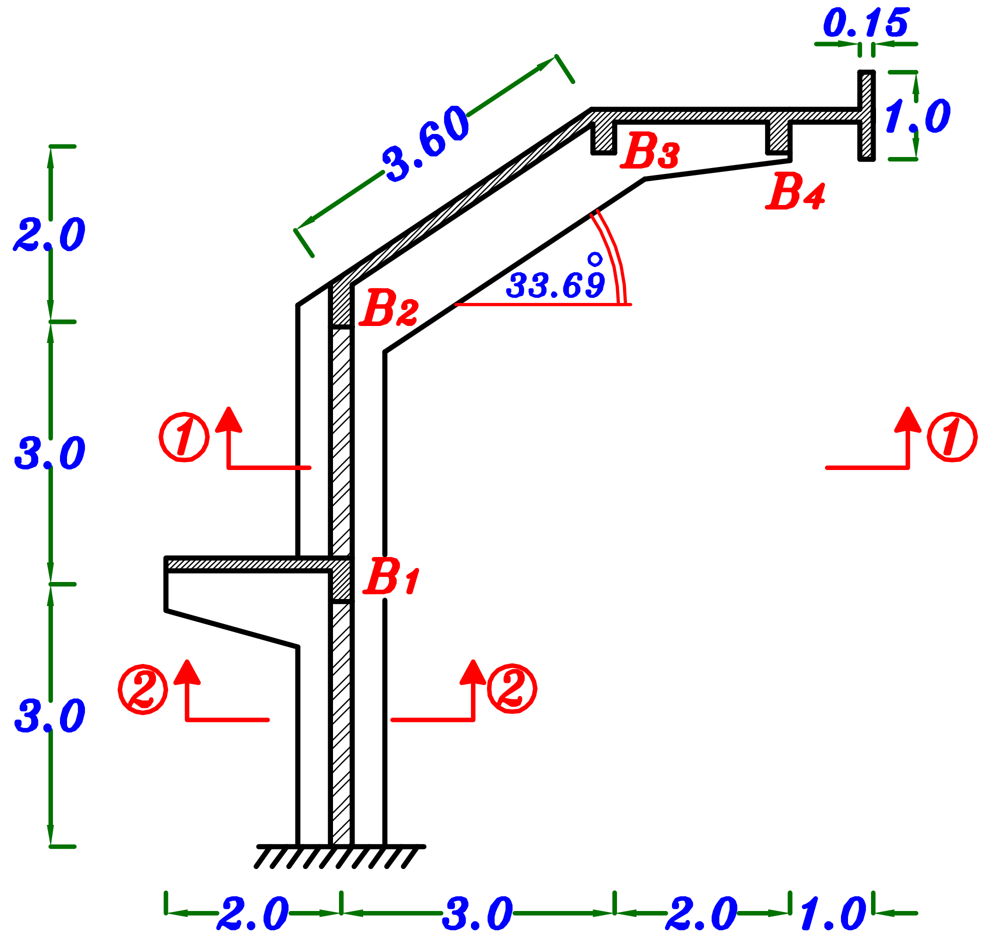
Data:

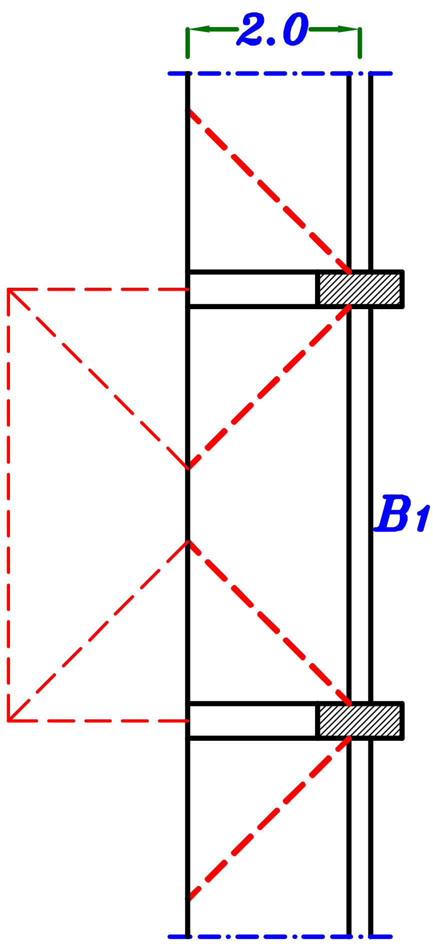
- Slab thickness $t_s = 120$ mm
- Live load = 1.0 kN\m² HL. projection.
- Floor cover = 1.5 kN\m²
- $b_{(beams)} = 0.25$ m , $b_{(Frame)} = 0.30$ m , $\gamma_{brick} = 18$ kN\m³
- Own weight of beams = 3.0 kN\m
- Own weight of Frame = 6.0 kN\m



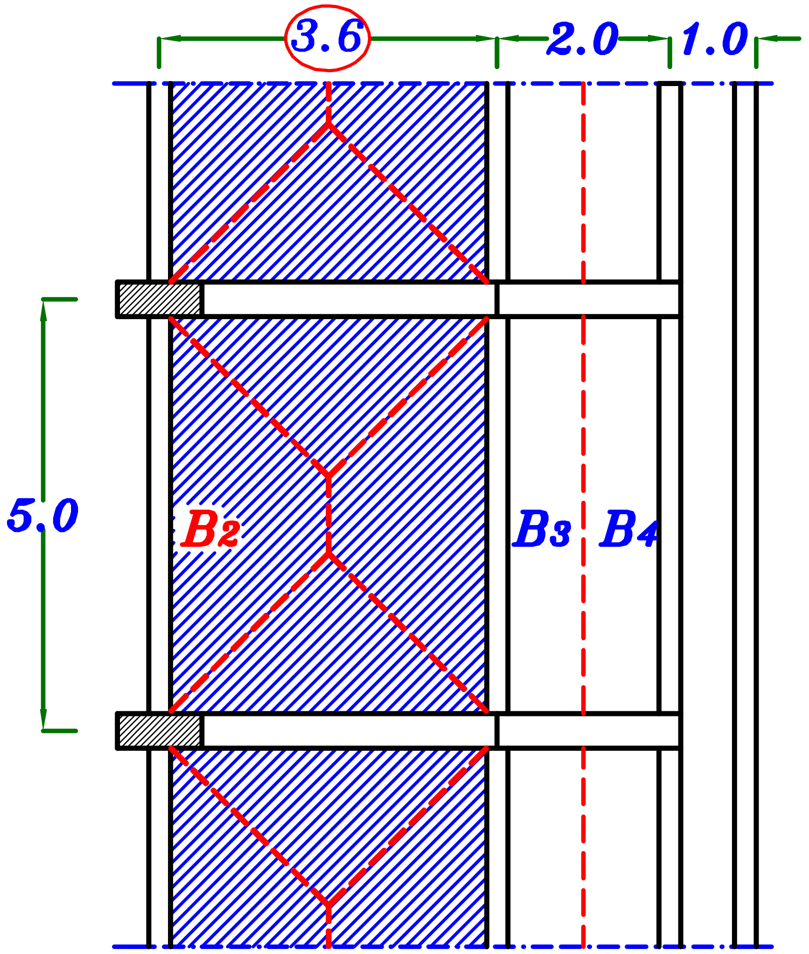
Statical System




0.15
1.0
3.60
B3
B4
2.0
33.69°
B2
3.0
①
B1
②
3.0
2.0
3.0
2.0
1.0


2.0
B1

Plan ②


3.6
2.0
1.0
5.0
B2
B3
B4

Plan ①

2 – Calculate the equivalent working loads for shear and moment For all secondary beams (B_1 , B_2 , B_3 & B_4) and an intermediate Frame (F) .

g_s , p_s

$$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.50 \ kN\backslash m^2$$

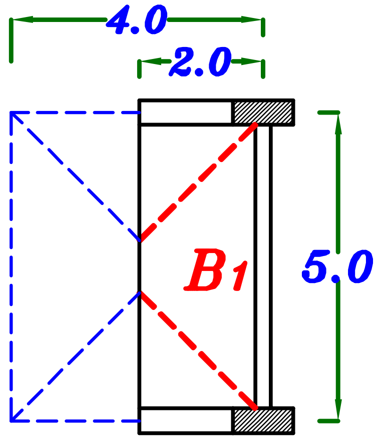
$$p_{sh} = L.L. = 1.0 \ kN\backslash m^2 \ \text{------ HL. Slab.}$$

$$p_{si} = L.L. * Cos\,\theta = 1.0 * Cos\,33.69^\circ = 0.83 \ kN\backslash m^2 \ \text{------ Inclined Slab.}$$

$\boxed{g_s = 4.50 \ kN\backslash m^2}$, $\boxed{p_{sh} = 1.0 \ kN\backslash m^2}$, $\boxed{p_{si} = 0.83 \ kN\backslash m^2}$

B_1

$$\text{Weight of Wall} = b\,h\,\gamma_{bricks} = (0.25)(3.0)(18.0) = 13.50 \ kN/m$$



For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{2L_c}{L}\right) = 1 - \frac{1}{2}\left(\frac{4}{5}\right) = 0.60$$

$$C_e = 1 - \frac{1}{3}\left(\frac{2L_c}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4}{5}\right)^2 = 0.78$$

Load For Shear.

$$g_a = O.W. + Wall + C_a\, g_s\, L_c = 3.0 + 13.5 + (0.60)(4.50)(2.0) = 21.9 \ kN\backslash m'$$

$$p_a = C_a\, p_{sh}\, L_c = (0.60)(1.0)(2.0) = 1.20 \ kN\backslash m'$$

$$w_a = g_a + p_a = 21.9 + 1.20 = 23.1 \ kN\backslash m'$$

$$R_1 = g_a * Spacing = 21.9 * 5.0 = 109.5 \ kN \ \text{------ D.L.}$$

$$= w_a * Spacing = 23.1 * 5.0 = 115.5 \ kN \ \text{------ T.L.}$$

$$\boxed{\begin{aligned} R_1 &= 109.5 \ kN \text{ ---- D.L.} \\ &= 115.5 \ kN \text{ ---- T.L.} \end{aligned}}$$

Load For Moment.

$$g_e = O.W. + Wall + C_e\, g_s\, L_c = 3.0 + 13.5 + (0.78)(4.50)(2.0) = 23.52 \ kN\backslash m'$$

$$p_e = C_e\, p_{sh}\, L_c = (0.78)(1.0)(2.0) = 1.56 \ kN\backslash m'$$

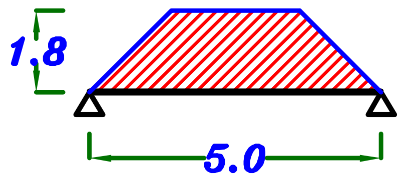
$$w_e = g_e + p_e = 23.52 + 1.56 = 25.08 \ kN\backslash m'$$

B_2

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.60}{5}\right) = 0.64$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.60}{5}\right)^2 = 0.83$$



Load For Shear.

$$g_a = O.W. + C_a\, g_s\, \frac{L_s}{2} = 3.0 + (0.64)(4.50)\left(\frac{3.6}{2}\right) = 8.18 \ kN\backslash m'$$

$$p_a = C_a\, p_{si}\, \frac{L_s}{2} = (0.64)(0.83)\left(\frac{3.6}{2}\right) = 0.95 \ kN\backslash m'$$

$$w_a = g_a + p_a = 8.18 + 0.95 = 9.13 \ kN\backslash m'$$

$$R_2 = g_a * Spacing = 8.18 * 5.0 = 40.9 \ kN \text{ ------ } D.L.$$

$$= w_a * Spacing = 9.13 * 5.0 = 45.65 \ kN \text{ ------ } T.L.$$

$$\boxed{\begin{aligned} R_2 &= 40.9 \ kN \text{ ------ } D.L. \\ &= 45.65 \ kN \text{ ----- } T.L. \end{aligned}}$$

Load For Moment.

$$g_e = O.W. + C_e\, g_s\, \frac{L_s}{2} = 3.0 + (0.83)(4.50)\left(\frac{3.6}{2}\right) = 9.72 \ kN\backslash m'$$

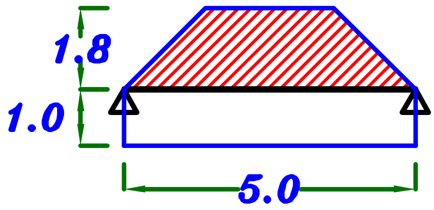
$$p_e = C_e\, p_{si}\, \frac{L_s}{2} = (0.83)(0.83)\left(\frac{3.6}{2}\right) = 1.24 \ kN\backslash m'$$

$$w_e = g_e + p_e = 9.72 + 1.24 = 10.96 \ kN\backslash m'$$

B_3 For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.60}{5}\right) = 0.64$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.60}{5}\right)^2 = 0.83$$



Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + g_s \frac{L_s}{2}$$

$$= 3.0 + (0.64)(4.50)\left(\frac{3.6}{2}\right) + (4.50)\left(\frac{2.0}{2}\right) = 12.68 \text{ kN\m`}$$

$$p_a = C_a\, p_{si} \frac{L_s}{2} + p_{sh} \frac{L_s}{2} = (0.64)(0.83)\left(\frac{3.6}{2}\right) + (1.0)\left(\frac{2.0}{2}\right) = 1.95 \text{ kN\m`}$$

$$w_a = g_a + p_a = 12.68 + 1.95 = 14.63 \text{ kN\m`}$$

$$R_3 = g_a * \text{Spacing} = 12.68 * 5.0 = 63.4 \text{ kN} \text{ ------ D.L.}$$

$$= w_a * \text{Spacing} = 14.63 * 5.0 = 73.15 \text{ kN} \text{ ------ T.L.}$$

$$\boxed{\begin{aligned} R_3 &= 63.4 \text{ kN ---- D.L.} \\ &= 73.15 \text{ kN ---- T.L.} \end{aligned}}$$

Load For Moment.

$$g_e = O.W. + C_e\, g_s \frac{L_s}{2} + g_s \frac{L_s}{2}$$

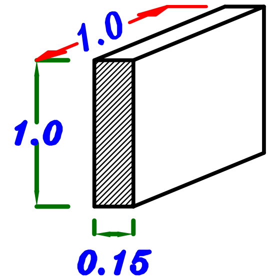
$$= 3.0 + (0.83)(4.50)\left(\frac{3.6}{2}\right) + (4.50)\left(\frac{2.0}{2}\right) = 14.22 \text{ kN\m`}$$

$$p_e = C_e\, p_{si} \frac{L_s}{2} + p_{sh} \frac{L_s}{2} = (0.83)(0.83)\left(\frac{3.6}{2}\right) + (1.0)\left(\frac{2.0}{2}\right) = 2.24 \text{ kN\m`}$$

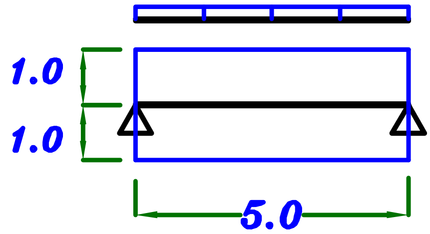
$$w_e = g_e + p_e = 14.22 + 2.24 = 16.46 \text{ kN\m`}$$

B_4

O.W. of the Parapet $= (0.15)(1.0)(1.0)(25) = 3.75\ kN\backslash m$



Load For Shear. = Load For Moment.



$$g_a = O.W. + Parapet + g_s \frac{L_s}{2} + g_s L_c$$

$$= 3.0 + 3.75 + (4.50)\left(\frac{2.0}{2}\right) + (4.50)(1.0) = 15.75\ kN\backslash m'$$

$$p_a = p_{sh}\frac{L_s}{2} + p_{sh} L_c = (1.0)\left(\frac{2.0}{2}\right) + (1.0)(1.0) = 2.0\ kN\backslash m'$$

$$w_a = g_a + p_a = 15.75 + 2.0 = 17.75\ kN\backslash m'$$

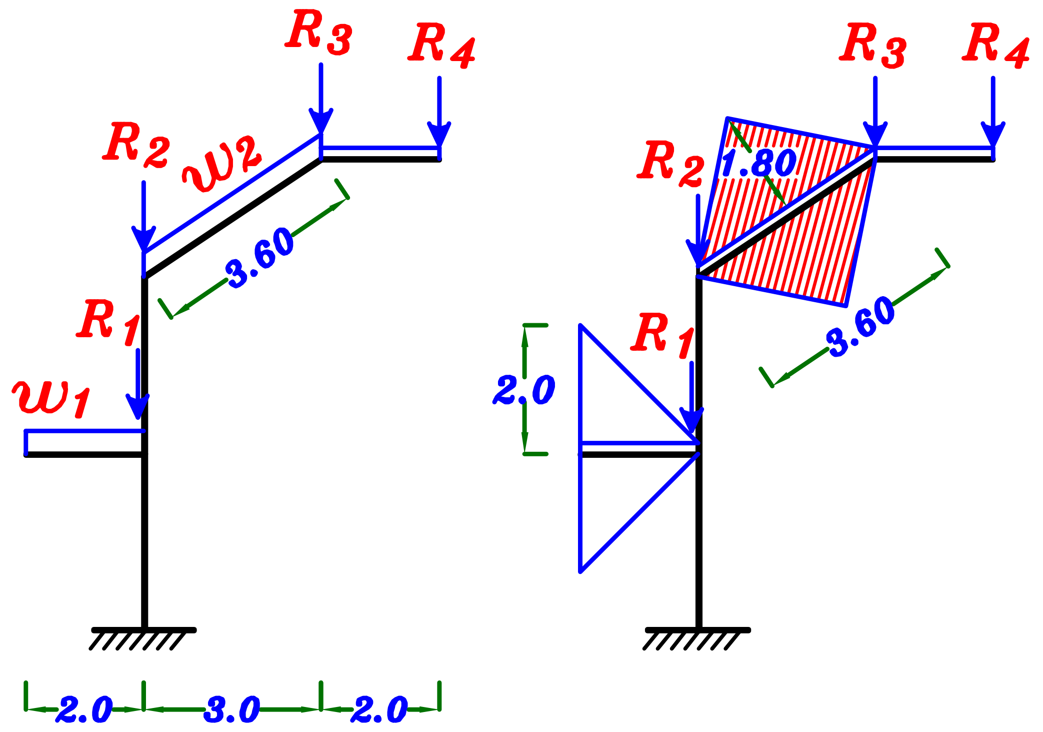
$R_4 = g_a * Spacing = 15.75 * 5.0 = 78.75\ kN$ ----- D.L.

$= w_a * Spacing = 17.75 * 5.0 = 88.75\ kN$ ----- T.L.

$R_4 = 78.75\ kN$ ----- D.L.

$= 88.75\ kN$ ----- T.L.

Frame.



W_1

For Triangle $C_a = \frac{1}{2}$, $C_e = \frac{2}{3}$

$$g_a = O.W. + 2\, C_a\, g_s\, L_c = 6.0 + 2\left(\tfrac{1}{2}\right)(4.5)(2.0) = 15.0 \text{ kN\textbackslash m`}$$

$$p_a = 2\, C_a\, p_{sh}\, L_c = 2\left(\tfrac{1}{2}\right)(1.0)(2.0) = 2.0 \text{ kN\textbackslash m`}$$

$$w_a = g_a + p_a = 15.0 + 2.0 = 17.0 \text{ kN\textbackslash m`}$$

$$g_e = O.W. + 2\, C_e\, g_s\, L_c = 6.0 + 2\left(\tfrac{2}{3}\right)(4.5)(2.0) = 18.0 \text{ kN\textbackslash m`}$$

$$p_e = 2\, C_e\, p_{sh}\, L_c = 2\left(\tfrac{2}{3}\right)(1.0)(2.0) = 2.67 \text{ kN\textbackslash m`}$$

$$w_e = g_e + p_e = 18.0 + 2.67 = 20.67 \text{ kN\textbackslash m`}$$

W_2

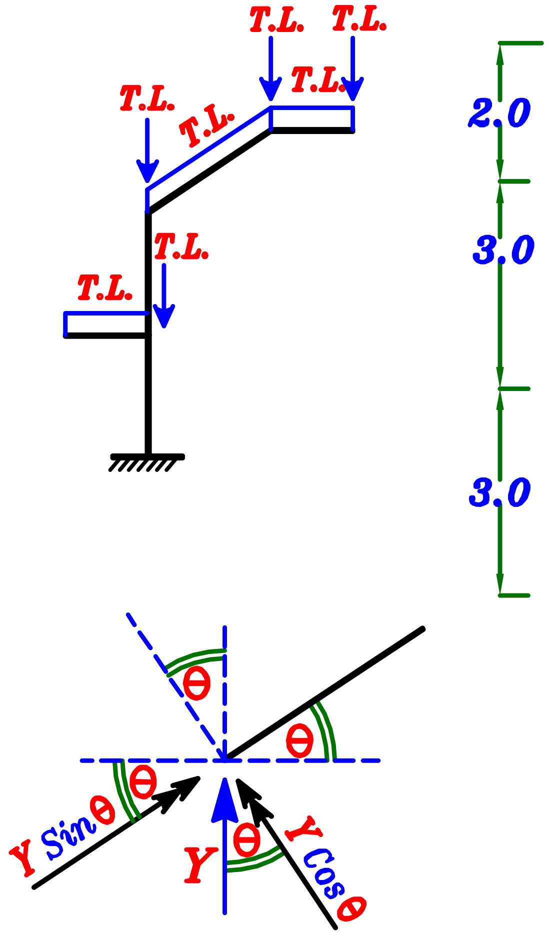
$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(3.6)(1.8)\right)}{3.6} = 1.80$$

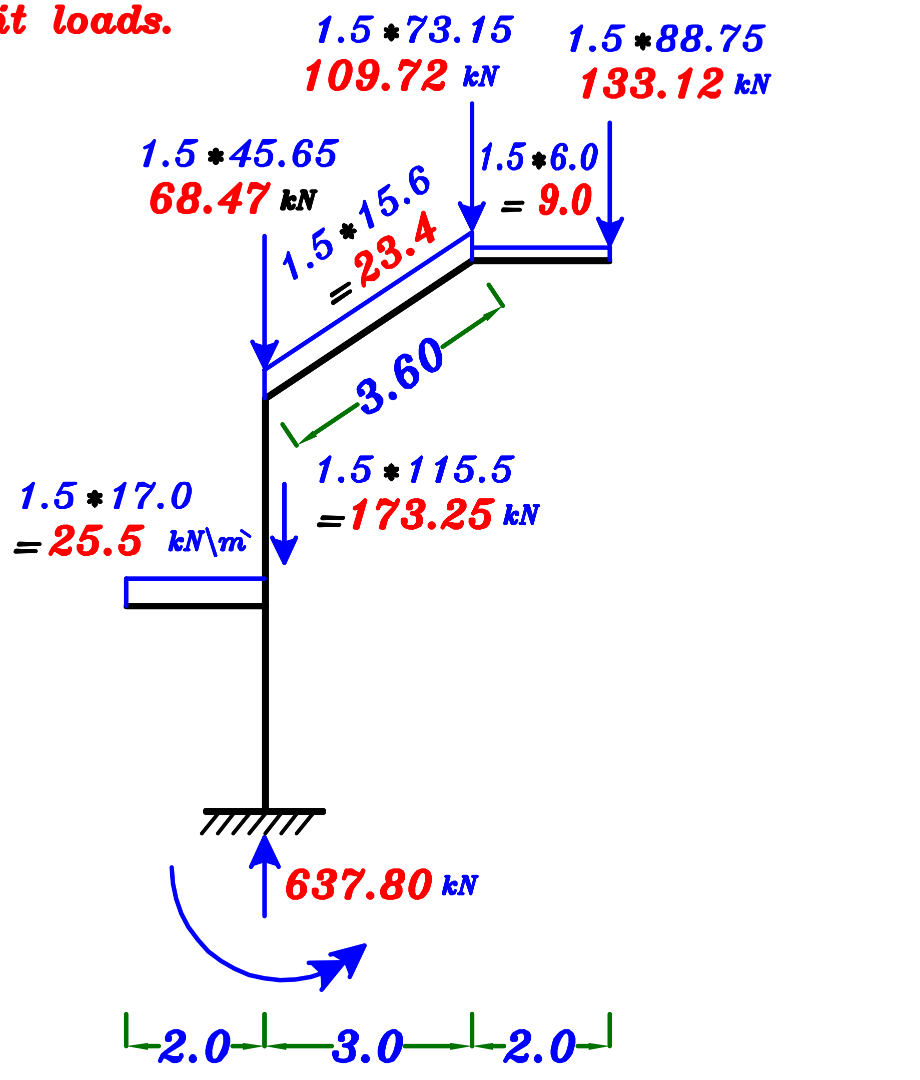
$$g_a = g_e = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.80)(4.50) = 14.1 \text{ kN\textbackslash m`}$$

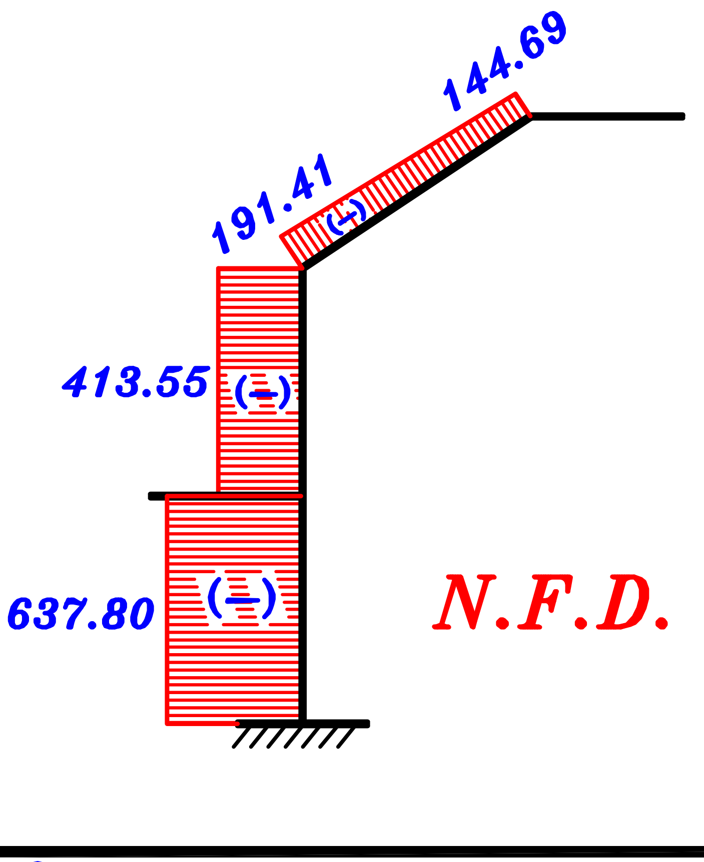
$$p_a = p_e = \frac{\sum area}{span} * p_{si} = (1.80)(0.83) = 1.50 \text{ kN\textbackslash m`}$$

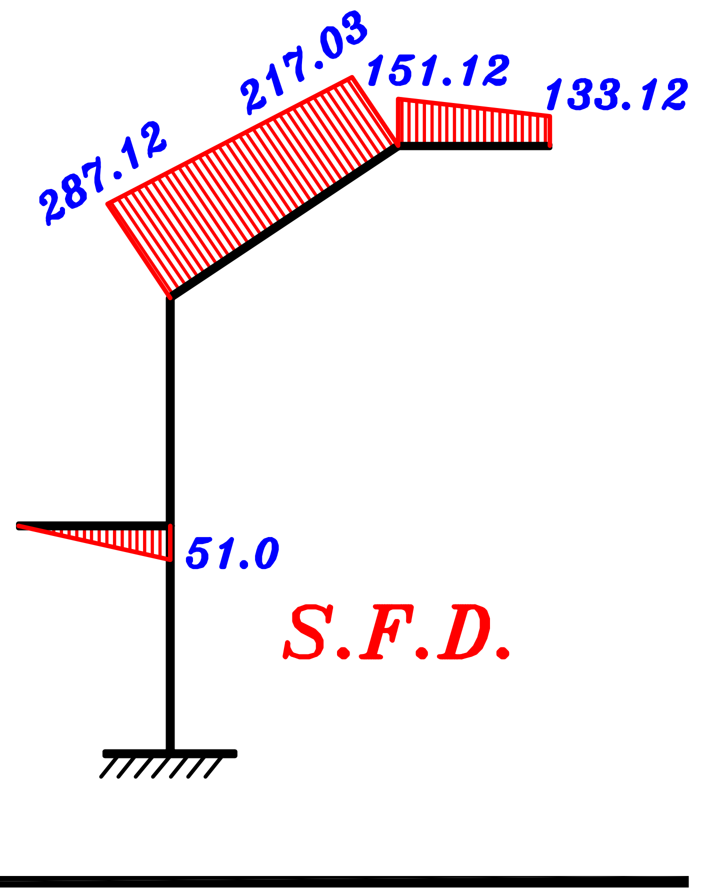
$$w_a = w_e = g_a + p_a = 14.1 + 1.50 = 15.60 \text{ kN\textbackslash m`}$$

3- Draw the N.F.D. (total load), S.F.D. (total load) For an intermediate Frame (F) using ultimate limit loads.

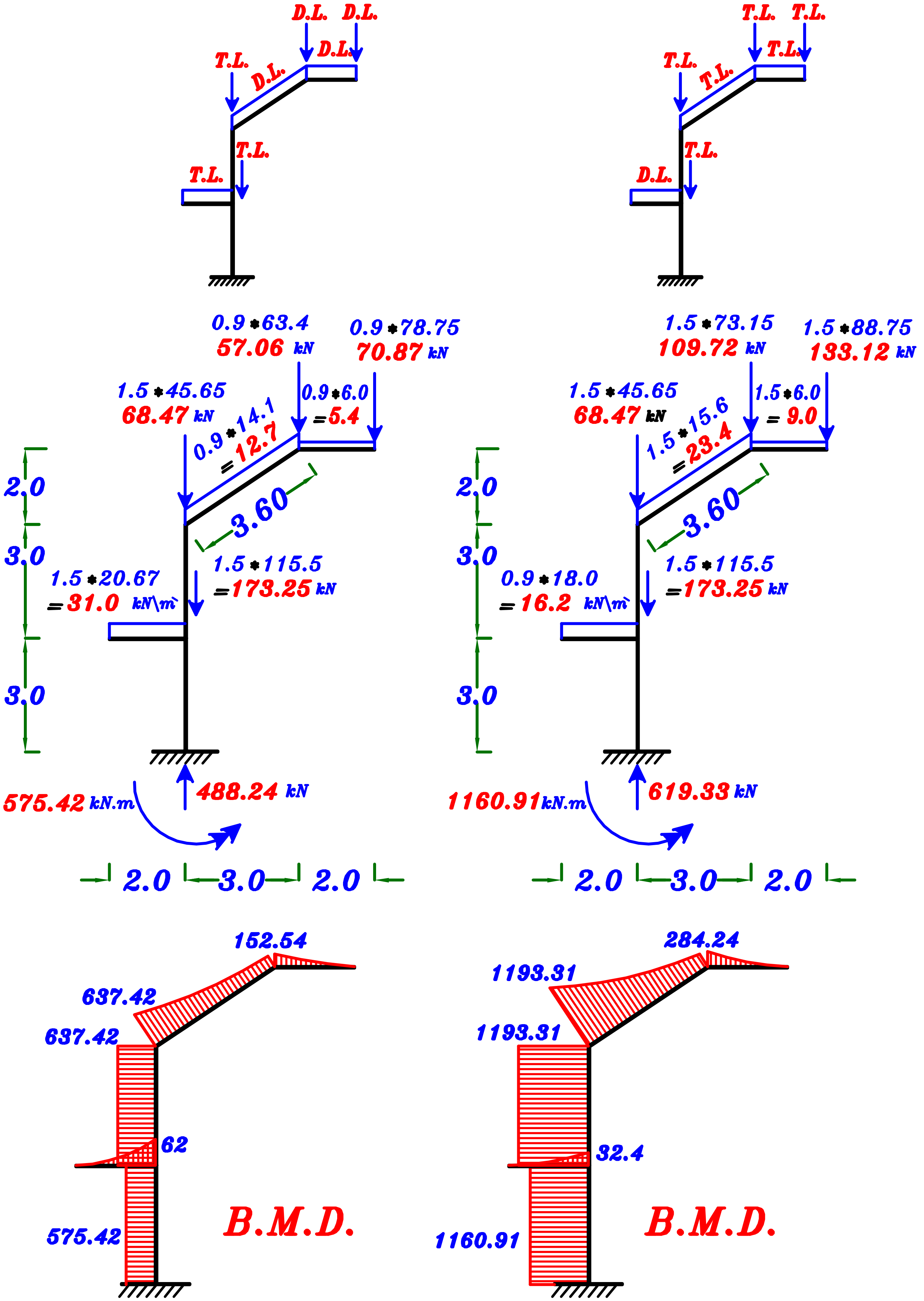


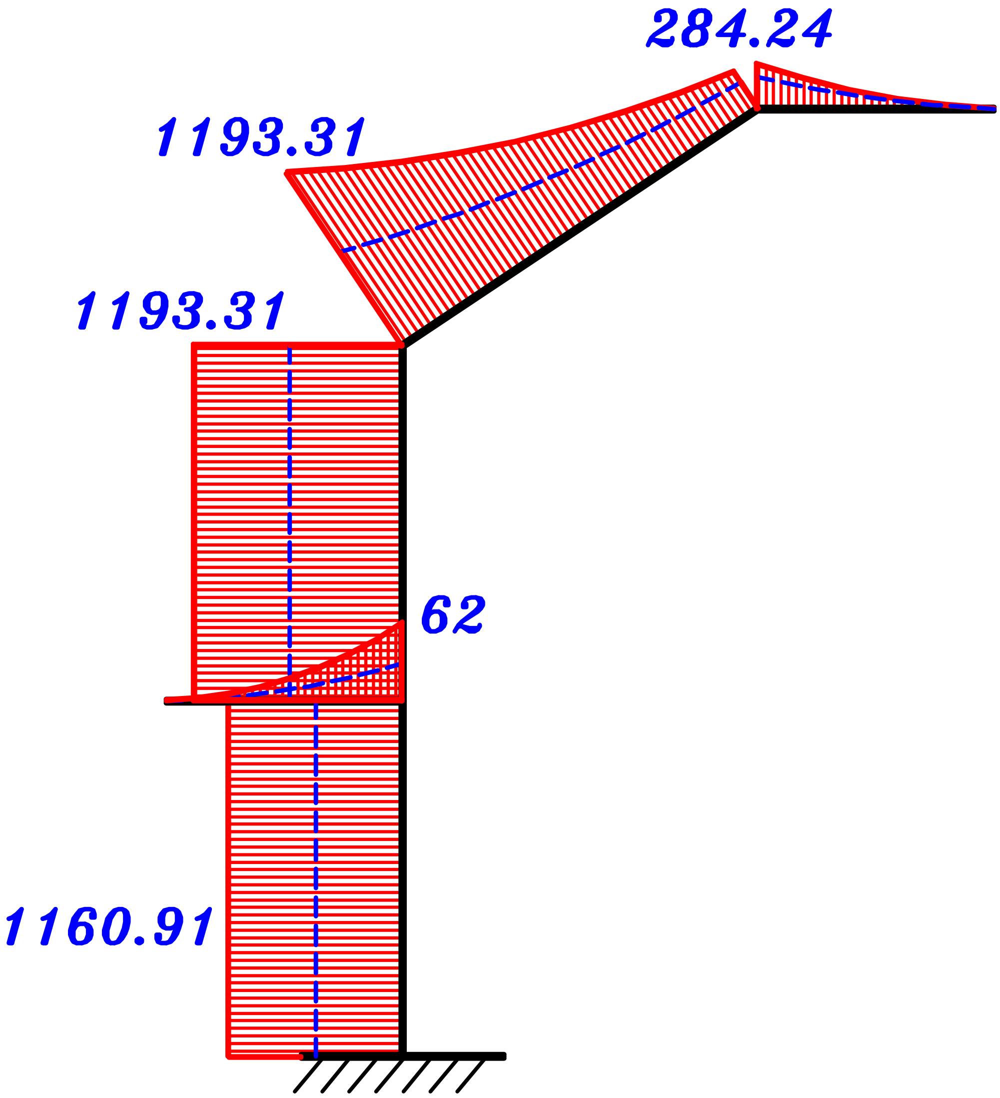






3- Draw the max-max B.M.D. For an intermediate Frame (F) using ultimate limit loads.





max-max B.M.D.

Example.

Figure 1 is showing the structural section of the covering system of a reinforced concrete hall. Using the Following data:

- The slab thickness $t_s = 140\ mm$
- The density of used bricks $= 15\ kN\backslash m^3$
- Live Load $= 2.0\ kN\backslash m^2$
- Floor cover Load $= 1.50\ kN\backslash m^2$
- Self weight of all beams and girders $= 3.50\ kN\backslash m$
- Spacing of the main girders $= 6.0\ m$

It is required :

1 – Draw the structural plans A–A & B–B showing the pattern of slab load distribution on all Beams.

2 – Calculate the equivalent loads For shear and moment For all beams.

3 – Draw the max–max bending moment diagram For girder G using Ultimate limits loads.

4 – Draw the shearing Force diagram For the case of total load only For girder G .

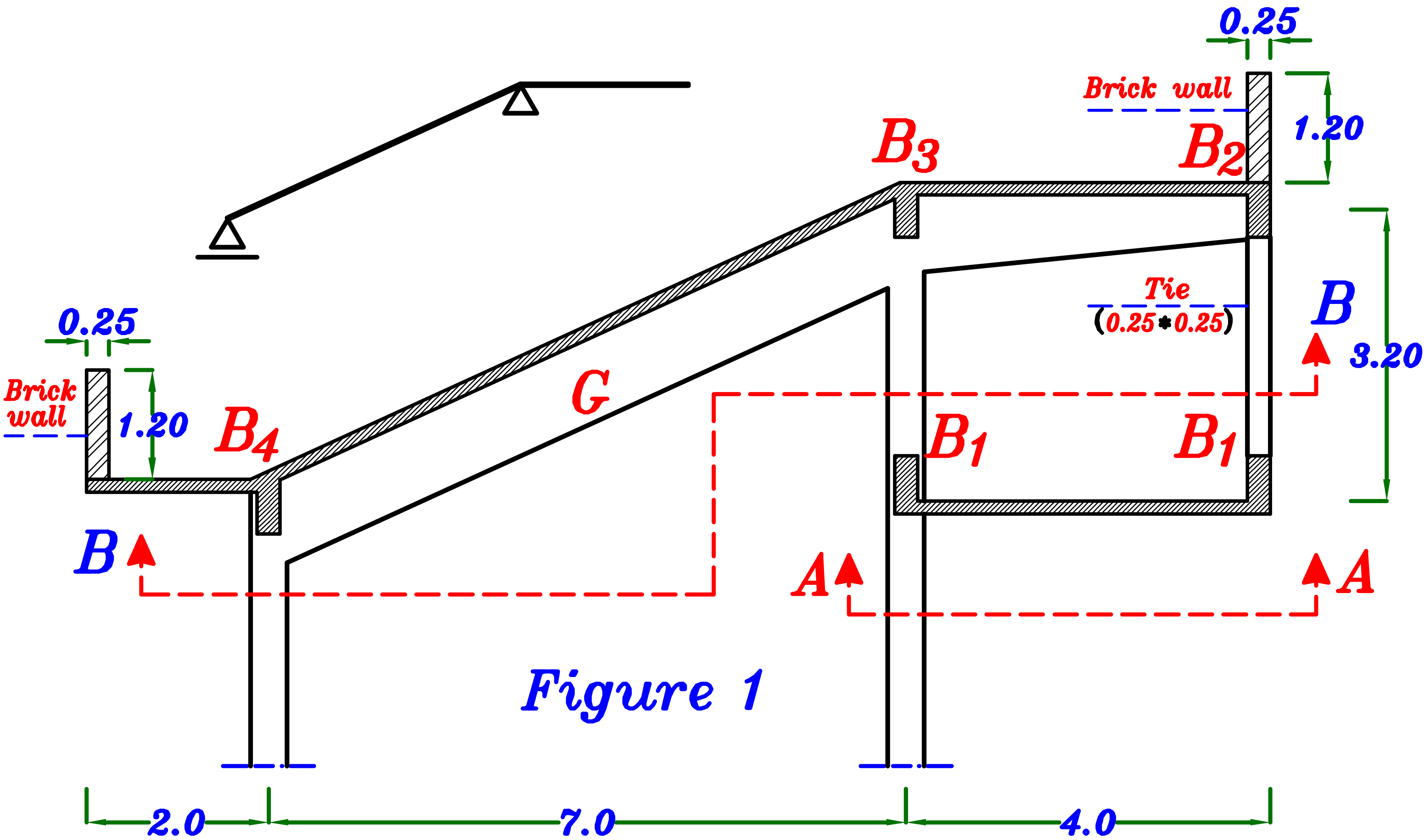


Figure 1

1 – Draw the structural plans A–A & B–B showing the pattern of slab load distribution on all Beams.

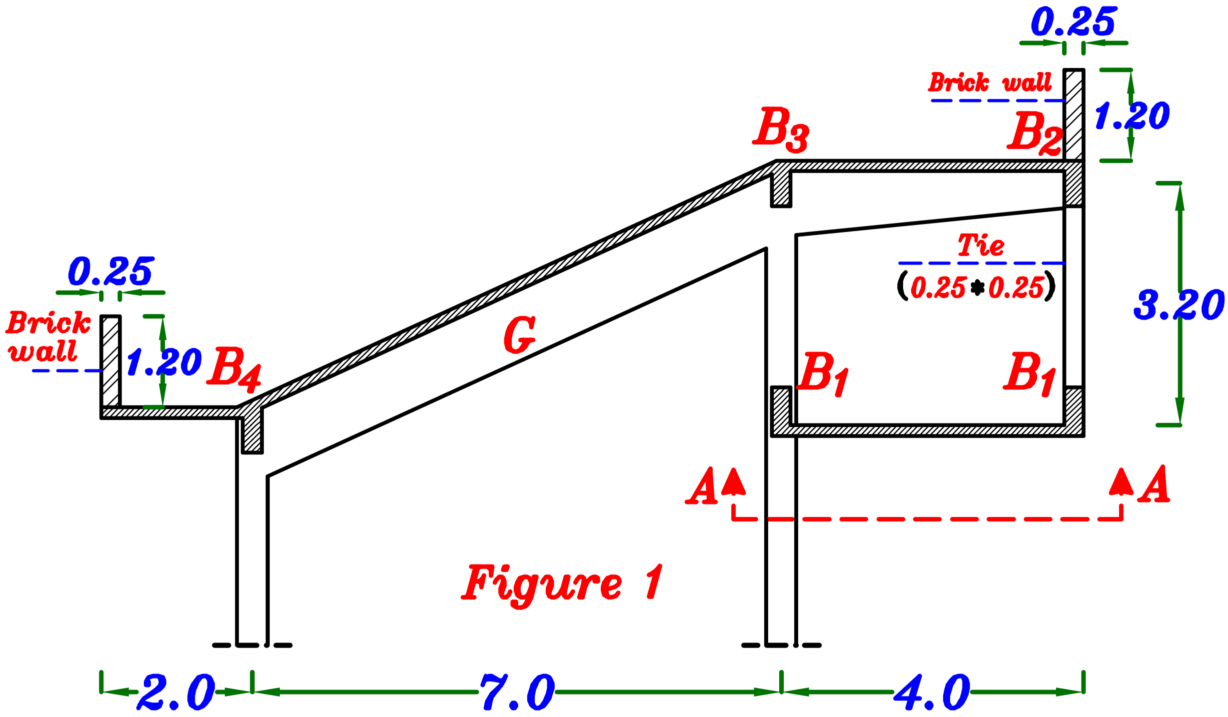
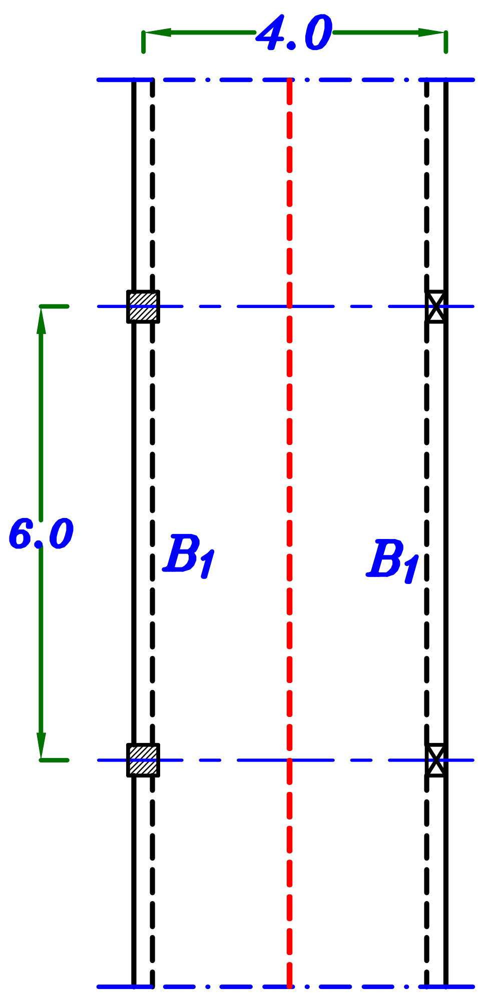
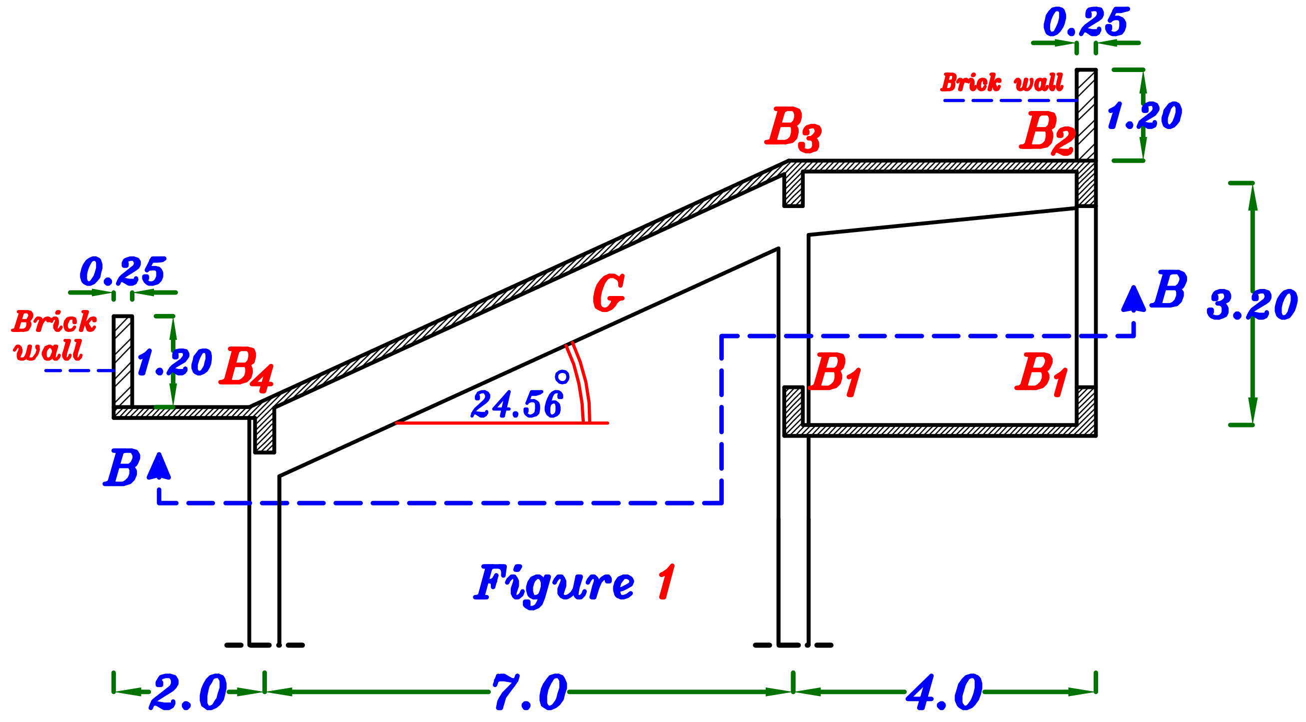
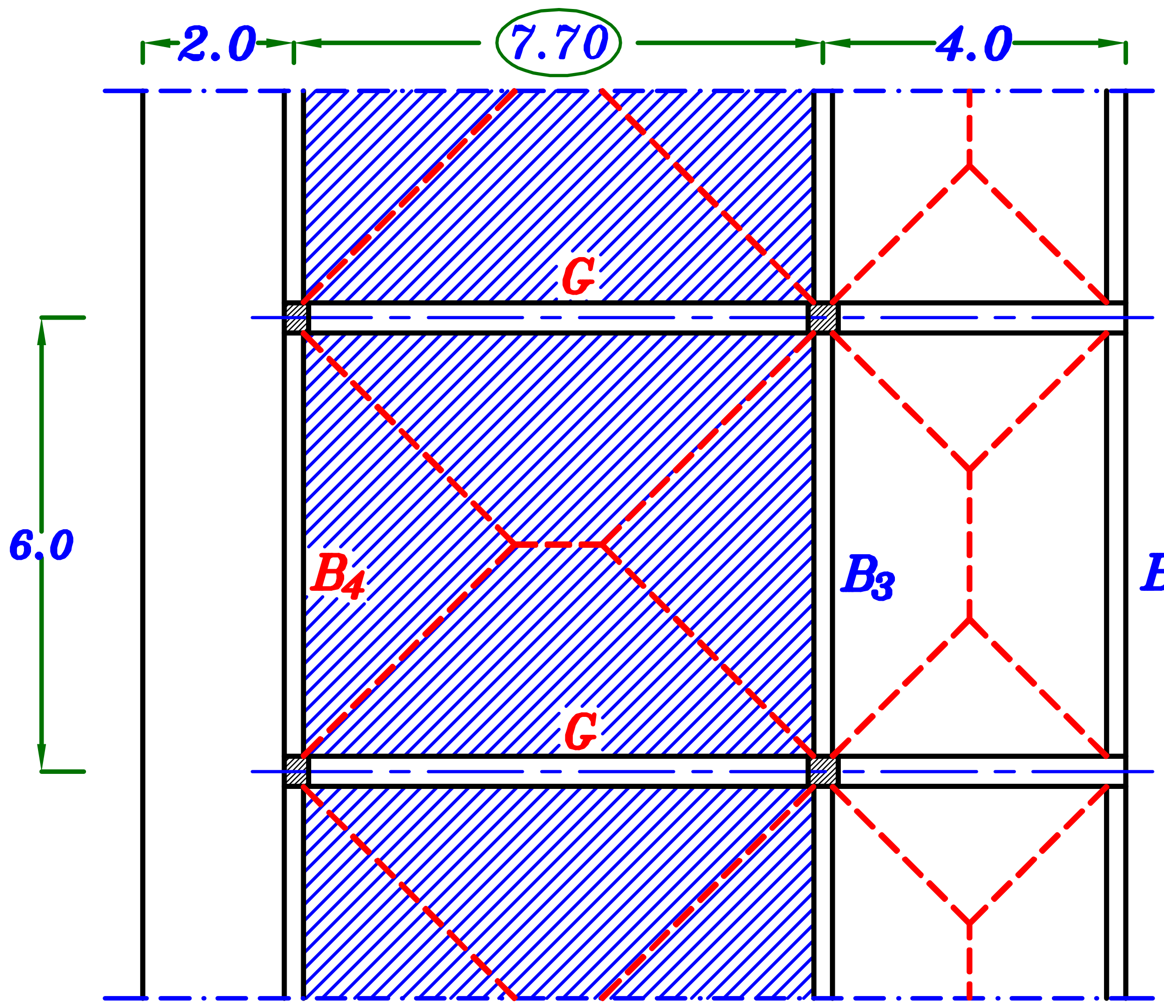


Figure 1



Plan A–A


0.25
Brick wall
1.20
B3
B2
3.20
B
G
0.25
Brick wall
1.20
B4
B1
B1
24.56°
B
Figure 1
2.0
7.0
4.0


2.0
7.70
4.0
G
6.0
B4
B3
B2
G

Plan B–B

2 – Calculate the equivalent loads For shear and moment For all beams.

g_s , p_s

$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 1.50 = 5.0 \quad kN\backslash m^2$

$p_{sh} = L.L. = 2.0 \quad kN\backslash m^2$ ------ HL. Slab.

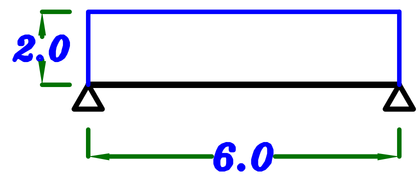
$p_{si} = L.L. * \cos\theta = 2.0 * \cos 24.56^\circ = 1.82 \quad kN\backslash m^2$ ------ Inclined Slab.

$\boxed{g_s = 5.0 \quad kN\backslash m^2}$, $\boxed{p_{sh} = 2.0 \, kN\backslash m^2}$, $\boxed{p_{si} = 1.82 \, kN\backslash m^2}$

B_1 Load For Shear. = Load For Moment.

$g_a = g_e = O.W. + g_s \frac{L_s}{2} = 3.5 + (5.0)\left(\frac{4.0}{2}\right)$

$= 13.50 \quad kN\backslash m`$



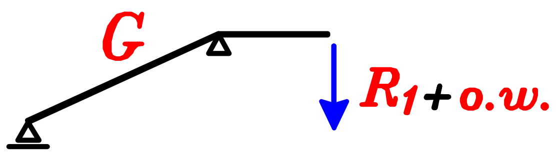
$p_a = p_e = p_{sh} \frac{L_s}{2} = (2.0)\left(\frac{4.0}{2}\right) = 4.0 \; kN\backslash m`$

$w_a = g_a + p_a = 13.50 + 4.0 = 17.50 \; kN\backslash m`$

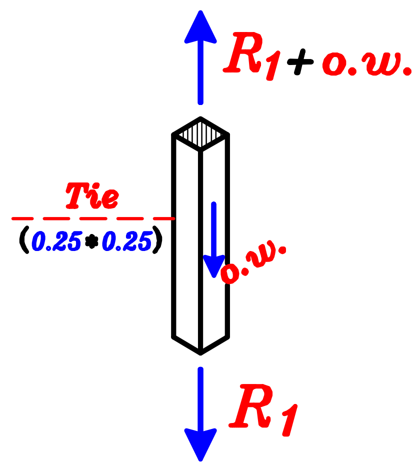
$R_1 = g_a * Spacing = 13.50 * 6.0 = 81.0 \; kN$ ------ D.L.

$= w_a * Spacing = 17.50 * 6.0 = 105 \; kN$ ------ T.L.

$R_1 = 81.0 \quad kN$ ----- D.L.
$= 105 \quad kN$ ----- T.L.



ينتقل ال reaction (R_1) من الكمره B_1 الى ال Tie
و منه الى ال Girder .



$o.w.(Tie) = (0.25 * 0.25 * 3.20) * 25$

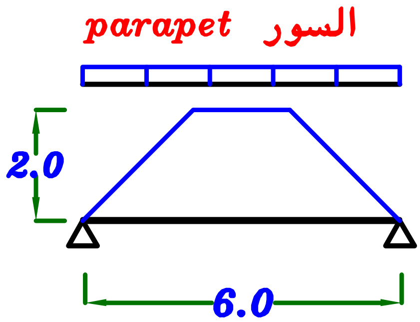
$= 5.0 \quad kN$

B_2

For Trapezoid 1 H.L.

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{6}\right) = 0.67$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{6}\right)^2 = 0.85$$



السور

$$parapet = b * h * \gamma_{wall} = 0.25 * 1.20 * 15.0 = 4.50 \ kN/m`$$

Load For Shear.

$$g_a = O.W. + parapet + C_a \, g_s \frac{L_s}{2} = 3.5 + 4.5 + (0.67)(5.0)\left(\frac{4.0}{2}\right) = 14.70 \ kN\backslash m`$$

$$p_a = C_a \, p_{sh} \frac{L_s}{2} = (0.67)(2.0)\left(\frac{4.0}{2}\right) = 2.68 \ kN\backslash m`$$

$$w_a = g_a + p_a = 14.70 + 2.68 = 17.38 \ kN\backslash m`$$

$$R_2 = g_a * Spacing = 14.70 * 6.0 = 88.20 \ kN \ \text{-----} \ D.L.$$

$$= w_a * Spacing = 17.38 * 6.0 = 104.3 \ kN \ \text{-----} \ T.L.$$

$$\boxed{\begin{aligned} R_2 &= 88.20 \ kN \ \text{---} \ D.L. \\ &= 104.3 \ kN \ \text{---} \ T.L. \end{aligned}}$$

Load For Moment.

$$g_e = O.W. + parapet + C_e \, g_s \frac{L_s}{2} = 3.5 + 4.5 + (0.85)(5.0)\left(\frac{4.0}{2}\right) = 16.5 \ kN\backslash m`$$

$$p_e = C_e \, p_{sh} \frac{L_s}{2} = (0.85)(2.0)\left(\frac{4.0}{2}\right) = 3.40 \ kN\backslash m`$$

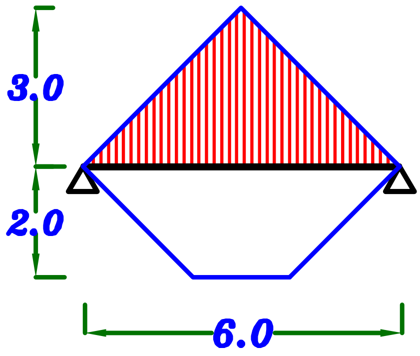
$$w_e = g_e + p_e = 16.5 + 3.40 = 19.90 \ kN\backslash m`$$

B_3

For Trapezoid 1 H.L.

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{6}\right) = 0.67$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{6}\right)^2 = 0.85$$



For triangle $C_a = \frac{1}{2}$ $C_e = \frac{2}{3}$

Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + C_a\, g_s \frac{L_s}{2}$$

$$= 3.5 + (0.67)(5.0)\left(\frac{4.0}{2}\right) + \left(\frac{1}{2}\right)(5.0)\left(\frac{6.0}{2}\right) = 17.70\ kN\backslash m'$$

$$p_a = C_a\, p_{sh} \frac{L_s}{2} + C_a\, p_{si} \frac{L_s}{2}$$

$$= (0.67)(2.0)\left(\frac{4.0}{2}\right) + \left(\frac{1}{2}\right)(1.82)\left(\frac{6.0}{2}\right) = 5.41\ kN\backslash m'$$

$$w_a = g_a + p_a = 17.70 + 5.41 = 23.11\ kN\backslash m'$$

Load For Moment.

$$g_e = O.W. + C_e\, g_s \frac{L_s}{2} + C_e\, g_s \frac{L_s}{2}$$

$$= 3.5 + (0.85)(5.0)\left(\frac{4.0}{2}\right) + \left(\frac{2}{3}\right)(5.0)\left(\frac{6.0}{2}\right) = 22.0\ kN\backslash m'$$

$$p_e = C_e\, p_{sh} \frac{L_s}{2} + C_e\, p_{si} \frac{L_s}{2}$$

$$= (0.85)(2.0)\left(\frac{4.0}{2}\right) + \left(\frac{2}{3}\right)(1.82)\left(\frac{6.0}{2}\right) = 7.04\ kN\backslash m'$$

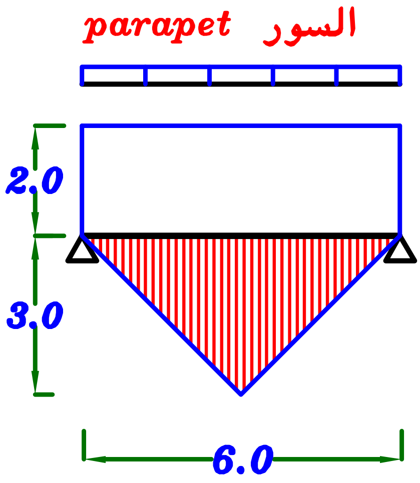
$$w_e = g_e + p_e = 22.0 + 7.04 = 29.04\ kN\backslash m'$$

B_4

السور

$$parapet = b * h * \gamma_{wall}$$

$$= 0.25 * 1.20 * 15.0 = 4.50 \ kN/m'$$



Load For Shear.

$$g_a = O.W. + parapet + g_s \, L_c + C_a \, g_s \, \frac{L_s}{2}$$

$$= 3.5 + 4.5 + (5.0)(2.0) + (\tfrac{1}{2})(5.0)(\tfrac{6.0}{2}) = 25.5 \ kN\backslash m'$$

$$p_a = p_{sh} \, L_c + C_a \, p_{si} \, \frac{L_s}{2}$$

$$= (2.0)(2.0) + (\tfrac{1}{2})(1.82)(\tfrac{6.0}{2}) = 6.73 \ kN\backslash m'$$

$$w_a = g_a + p_a = 25.5 + 6.73 = 32.23 \ kN\backslash m'$$

Load For Moment.

$$g_e = O.W. + parapet + g_s \, L_c + C_e \, g_s \, \frac{L_s}{2}$$

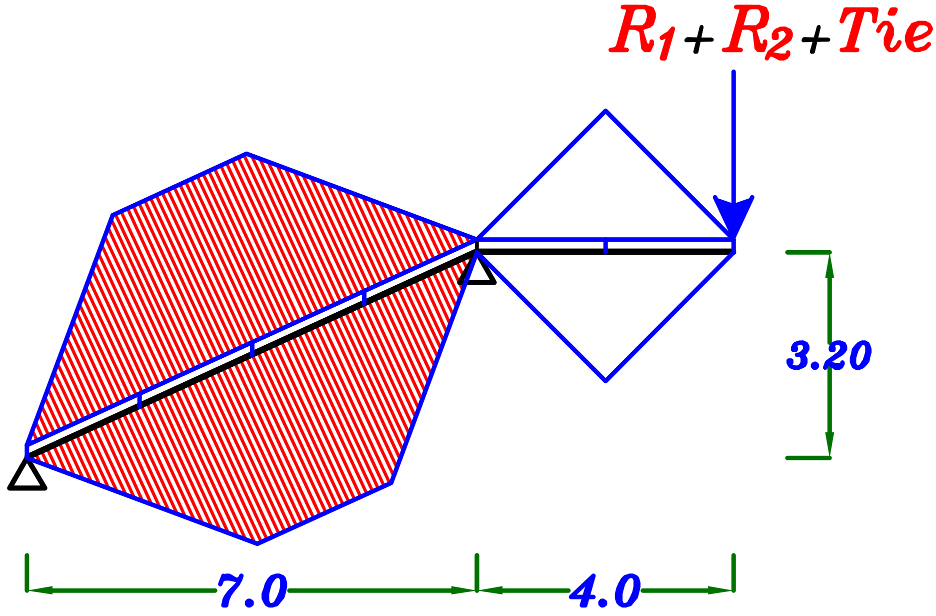
$$= 3.5 + 4.5 + (5.0)(2.0) + (\tfrac{2}{3})(5.0)(\tfrac{6.0}{2}) = 28.0 \ kN\backslash m'$$

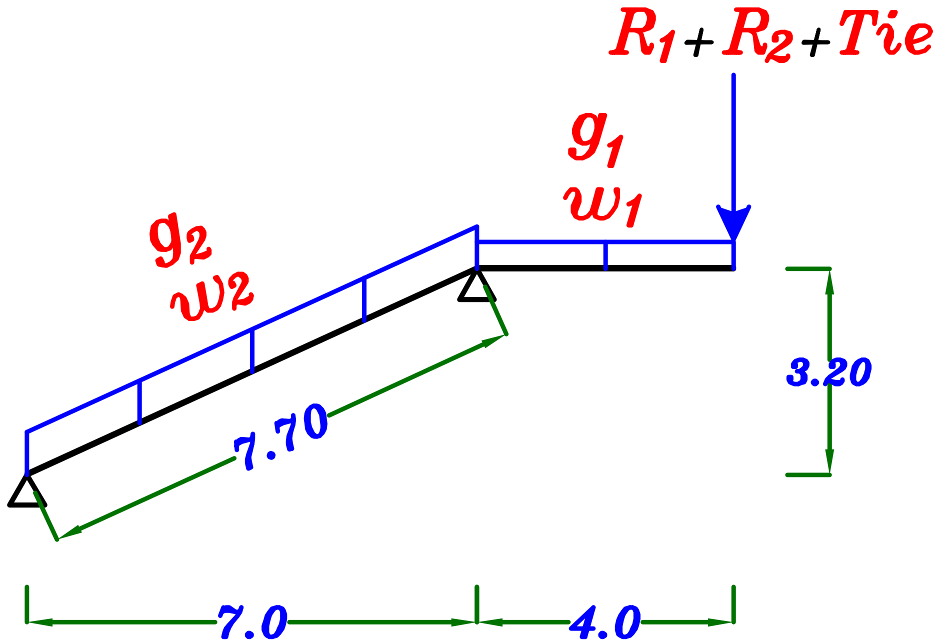
$$p_e = p_{sh} \, L_c + C_e \, p_{si} \, \frac{L_s}{2}$$

$$= (2.0)(2.0) + (\tfrac{2}{3})(1.82)(\tfrac{6.0}{2}) = 7.64 \ kN\backslash m'$$

$$w_e = g_e + p_e = 28.0 + 7.64 = 35.64 \ kN\backslash m'$$

G





w_1

For Triangle $C_a = \frac{1}{2}$, $C_e = \frac{1}{2}$

Load For Shear. = Load For Moment.

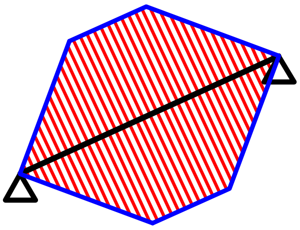
$$g_1 = O.W. + 2\, C_a\, g_s \frac{L_s}{2} = 3.50 + 2\left(\frac{1}{2}\right)(5.0)\left(\frac{4}{2}\right) = 13.5 \quad kN\backslash m`$$

$$p_1 = 2\, C_a\, p_{sh} \frac{L_s}{2} = 2\left(\frac{1}{2}\right)(2.0)\left(\frac{4}{2}\right) = 4.0 \quad kN\backslash m`$$

$$w_1 = g_1 + p_1 = 13.5 + 4.0 = 17.5 \quad kN\backslash m`$$

w_2

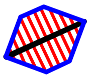
For Trapezoid 2 **Inclined**



$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{6.0}{7.7}\right) = 0.61$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{6.0}{7.7}\right)^2 = 0.80$$

Load For Shear.

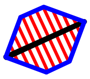


$$g_{2a} = O.W. + 2\, C_a\, g_s \frac{L_s}{2} = 3.50 + 2\,(0.61)\,(5.0)\left(\frac{6}{2}\right) = 21.80 \ \text{kN}\backslash\text{m}'$$

$$p_{2a} = 2\, C_a\, p_{si} \frac{L_s}{2} = 2\,(0.61)\,(1.82)\left(\frac{6}{2}\right) = 6.66 \ \text{kN}\backslash\text{m}'$$

$$w_{2a} = g_{2a} + p_{2a} = 21.80 + 6.66 = 28.46 \ \text{kN}\backslash\text{m}'$$

Load For Moment.

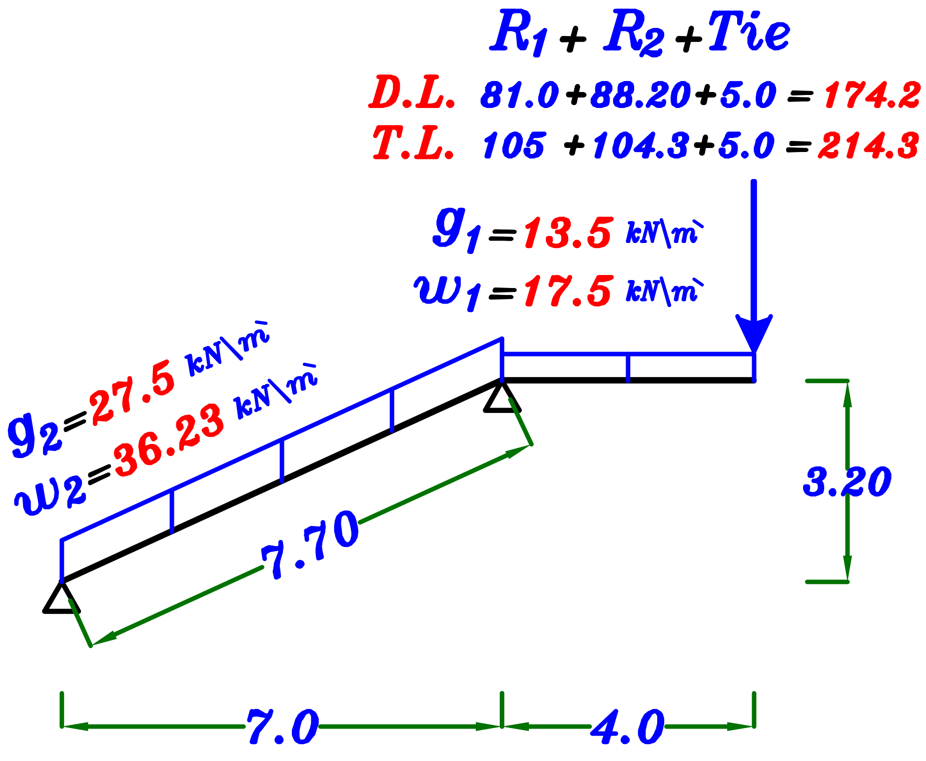


$$g_{2e} = O.W. + 2\, C_e\, g_s \frac{L_s}{2} = 3.50 + 2\,(0.80)\,(5.0)\left(\frac{6}{2}\right) = 27.50 \ \text{kN}\backslash\text{m}'$$

$$p_{2e} = 2\, C_e\, p_{si} \frac{L_s}{2} = 2\,(0.80)\,(1.82)\left(\frac{6}{2}\right) = 8.73 \ \text{kN}\backslash\text{m}'$$

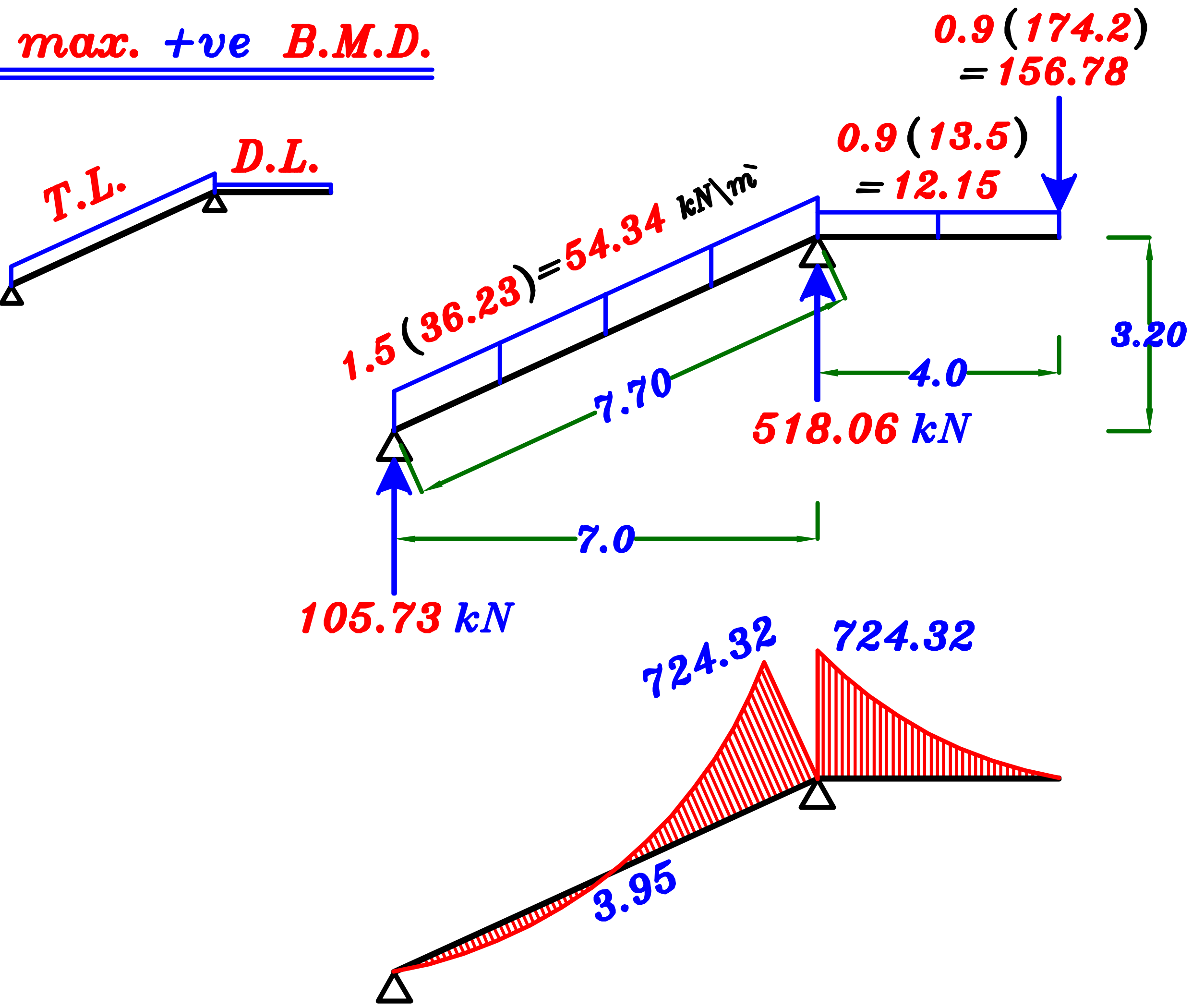
$$w_{2e} = g_{2e} + p_{2e} = 27.50 + 8.73 = 36.23 \ \text{kN}\backslash\text{m}'$$

3- Draw the max-max bending moment diagram For girder G using Ultimate limits loads.

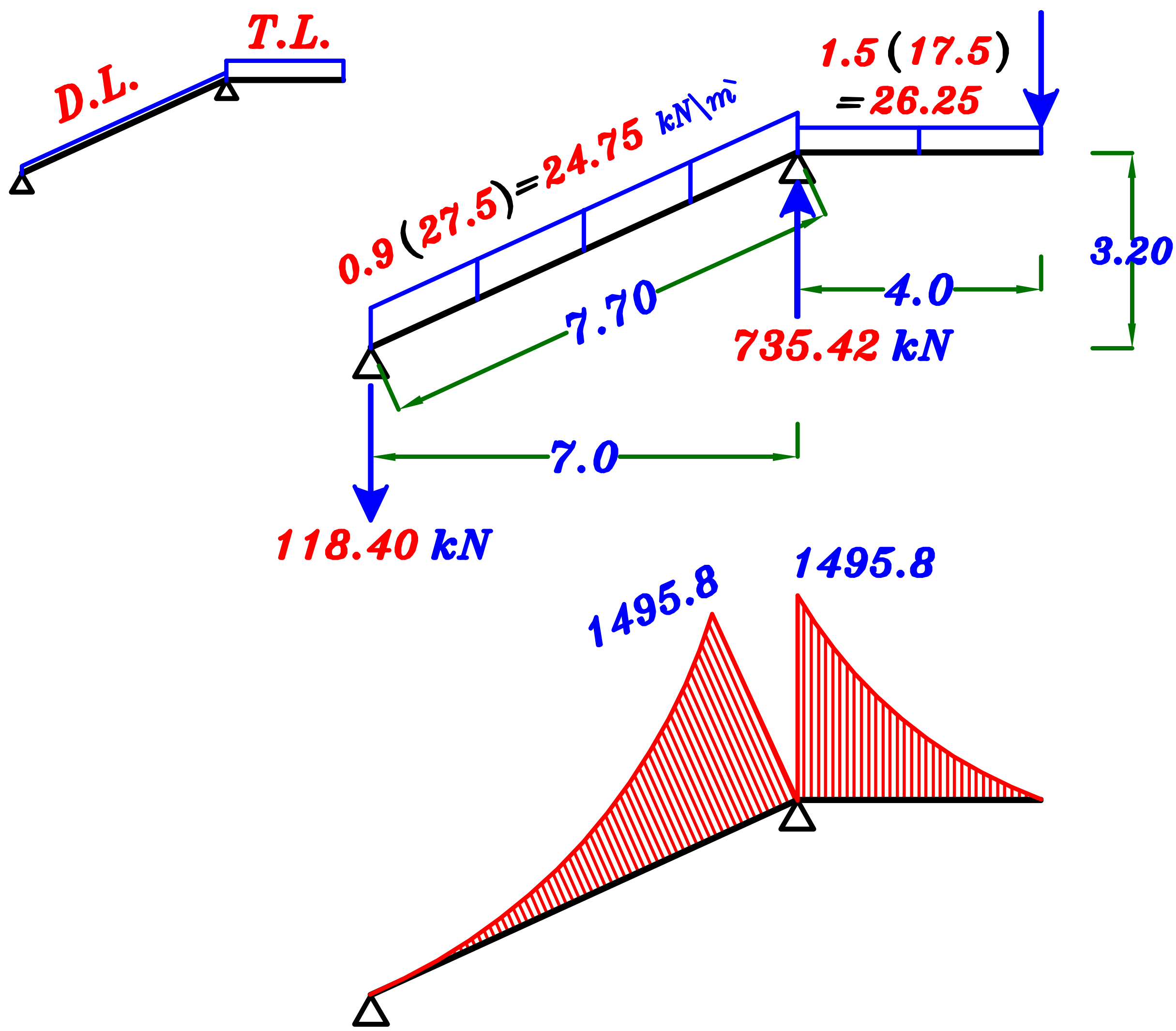


max-max B.M.D. For the Girder.

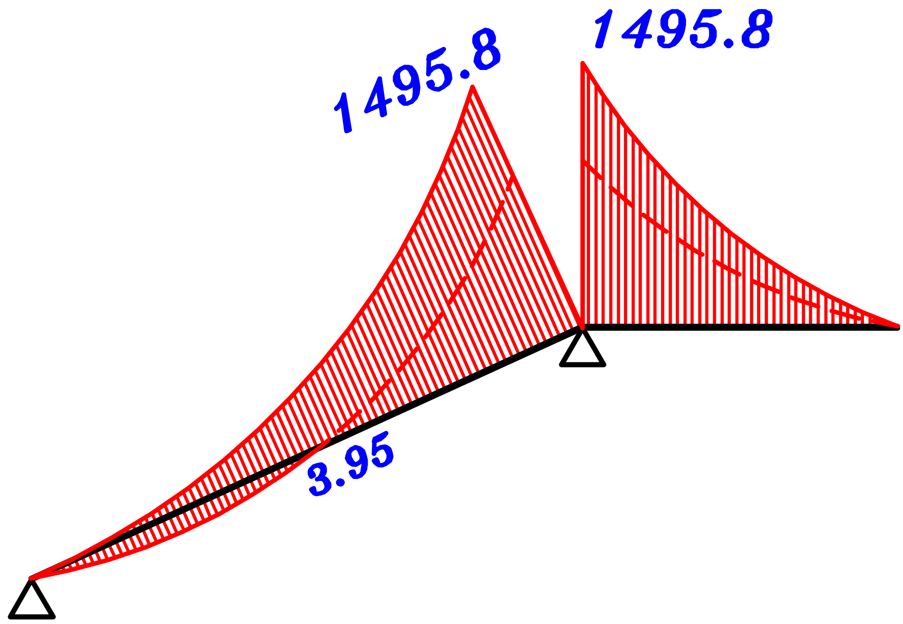
1_ max. +ve B.M.D.



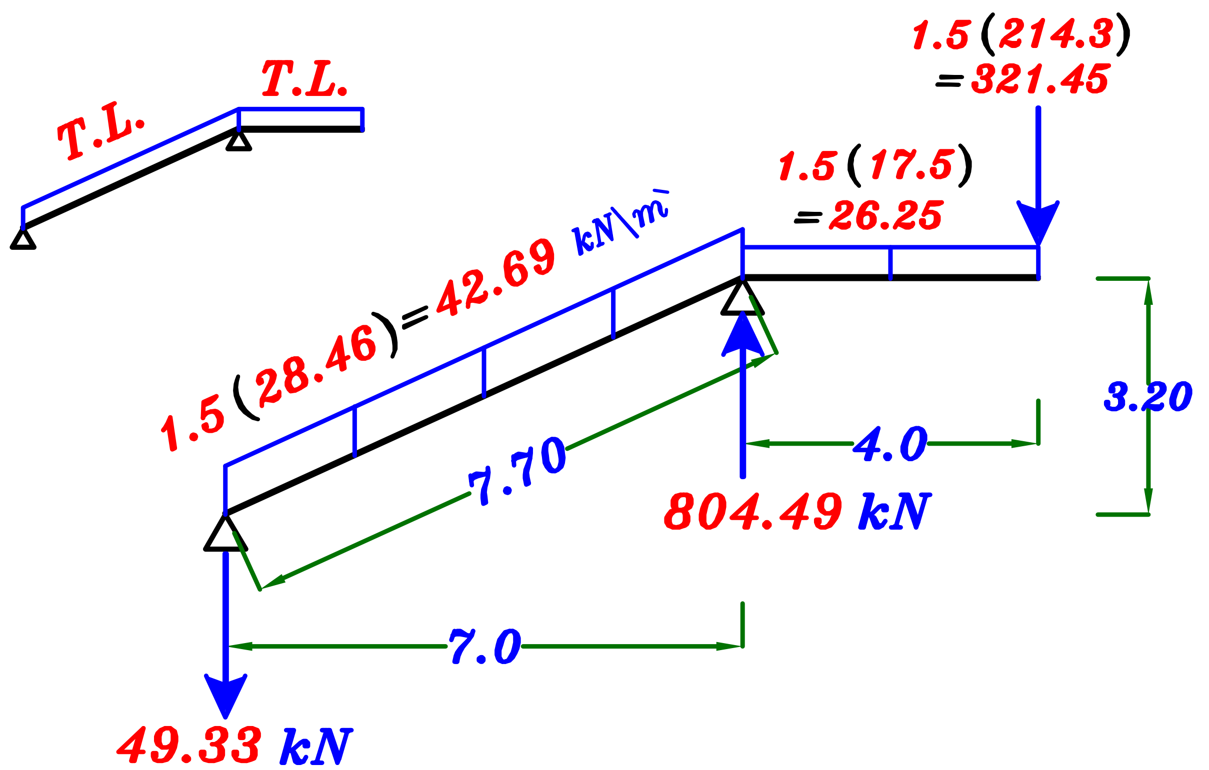
2- max. -ve B.M.D.

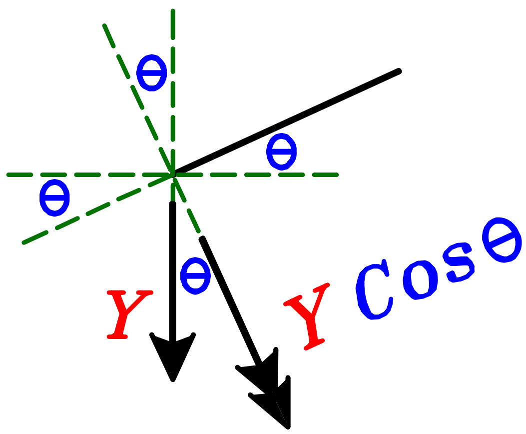


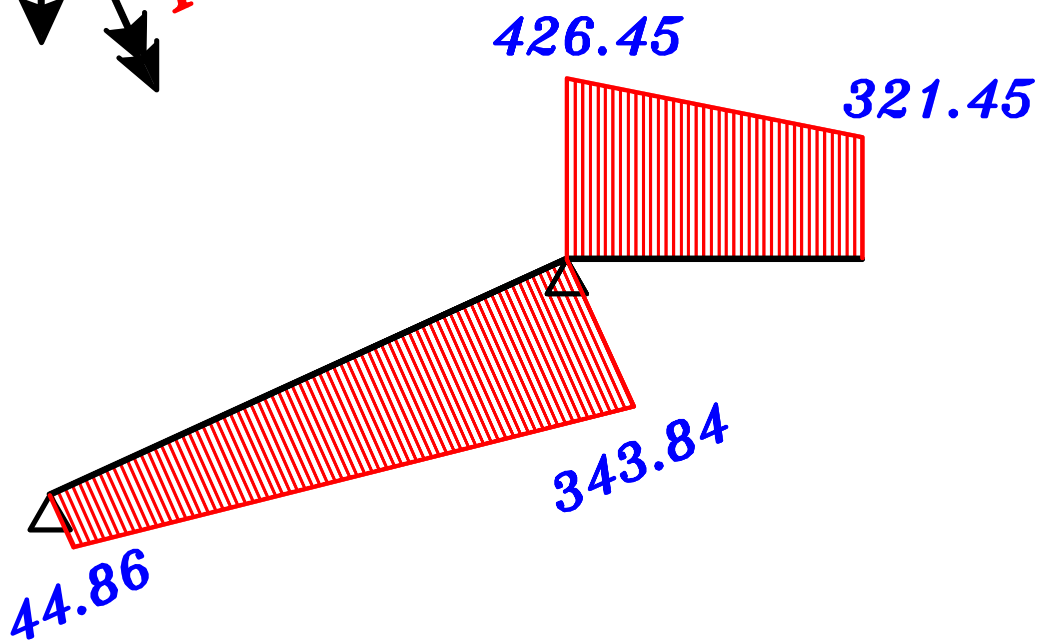
max-max B.M.D. For the Girder.



4- Draw the shearing Force diagram For the case of total load only For girder G.

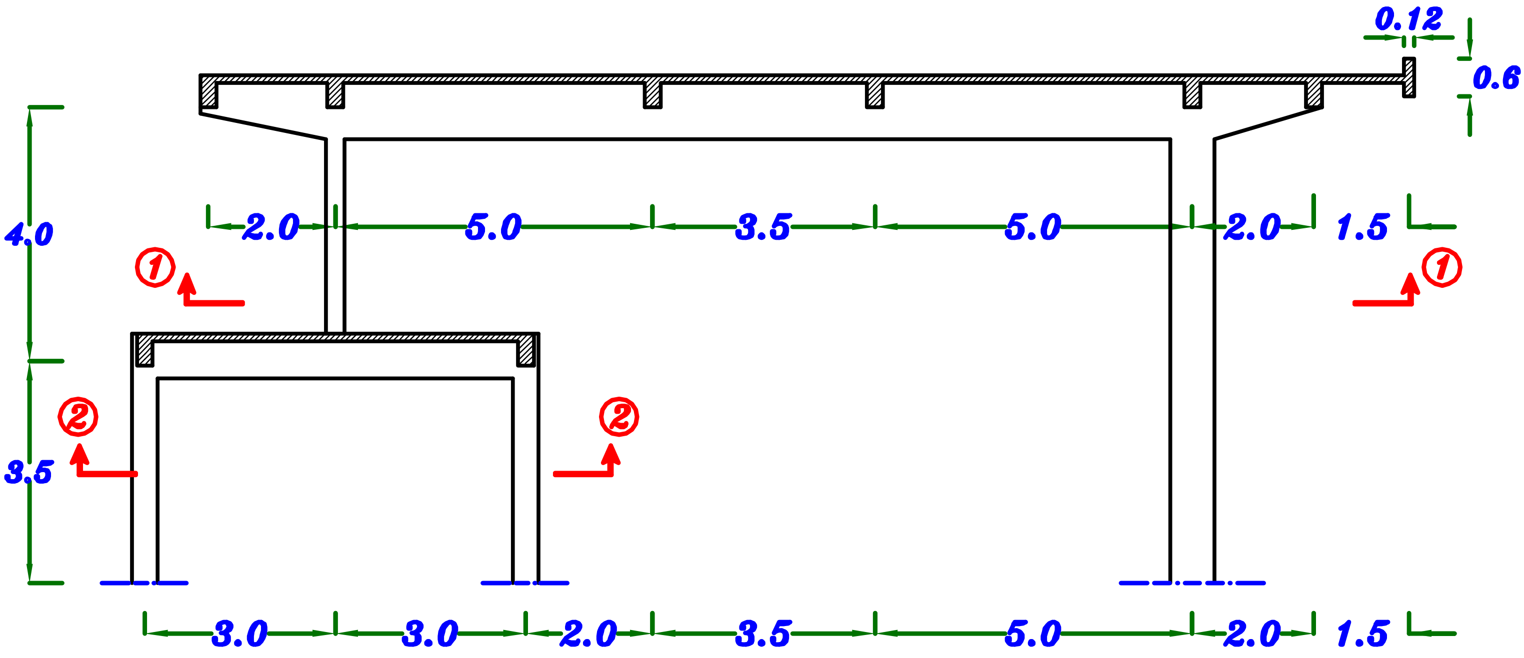






S.F.D.

Example.



Data.

$t_s = 0.12\ m$

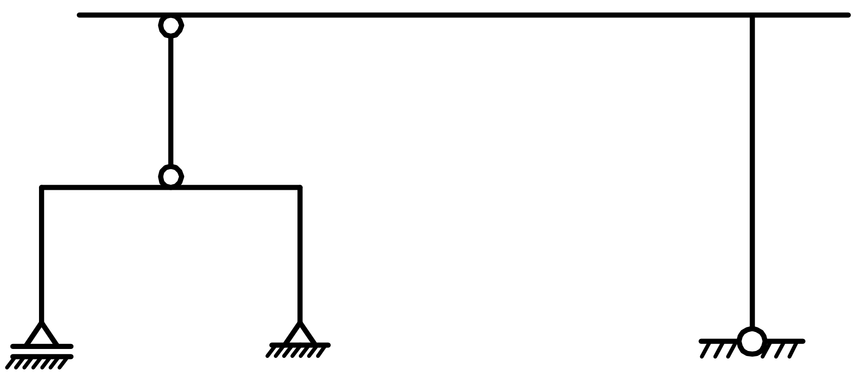
$F.C. = 2.0\ kN\backslash m^2$

$L.L. = 2.50\ kN\backslash m^2$

b (beam) $= 0.25\ m$

b (Frame) $= 0.35\ m$

Spacing $= 6.0\ m$



Statical System

Req.

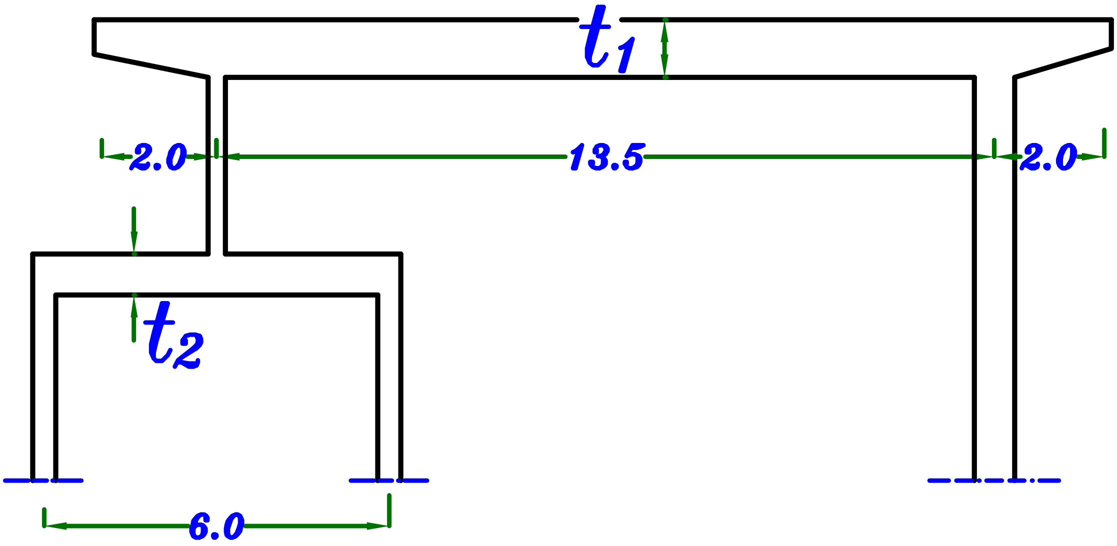
1- Estimate the concrete dimensions and own weight of the beams and Frame.

2- Draw plans ① & ② illustrate the pattern of load distribution.

3- Draw N.F.D. & S.F.D. (case of total load only) For the Frame.

4- Draw max-max B.M.D. For the Frame.

1 _ Estimate the concrete dimensions and own weight of the beams and Frame.



$$t_{secondary\ beams} = \frac{spacing}{12} = \frac{6.0}{12} = 0.50\ m$$

$$\text{upper Frame } t_1 = \frac{13.5}{12} = 1.125\ m$$
$$= \frac{2.0}{5} = 0.40\ m$$
$$\left.\right\} = 1.125\ m = 1.15\ m$$

$$\text{lower Frame } t_2 = \frac{6.0}{10} = 0.60\ m$$

$$\text{o.w. of Beams \& Frames} = b\, t\, \gamma_c$$

Beams $(250 * 500)$ o.w. $= (0.25)(0.5)(25) = 3.12\ kN\backslash m'$

upper Frame (F_1) $(350 * 1150)$ o.w. $= (0.35)(1.15)(25) = 10.0\ kN\backslash m'$

lower Frame (F_2) $(350 * 600)$ o.w. $= (0.35)(0.60)(25) = 5.25\ kN\backslash m'$

---

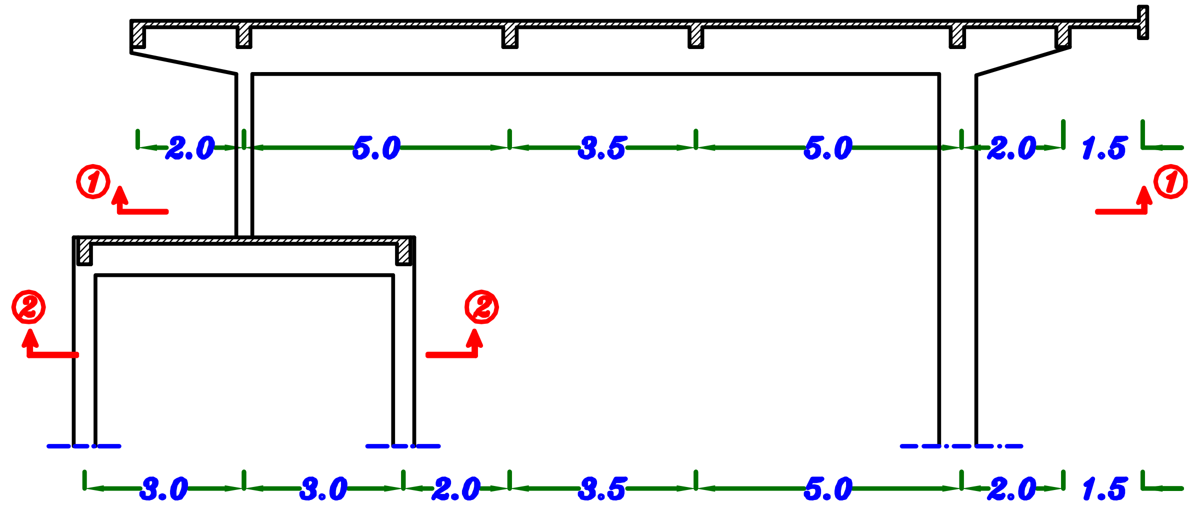
g_s , p_s

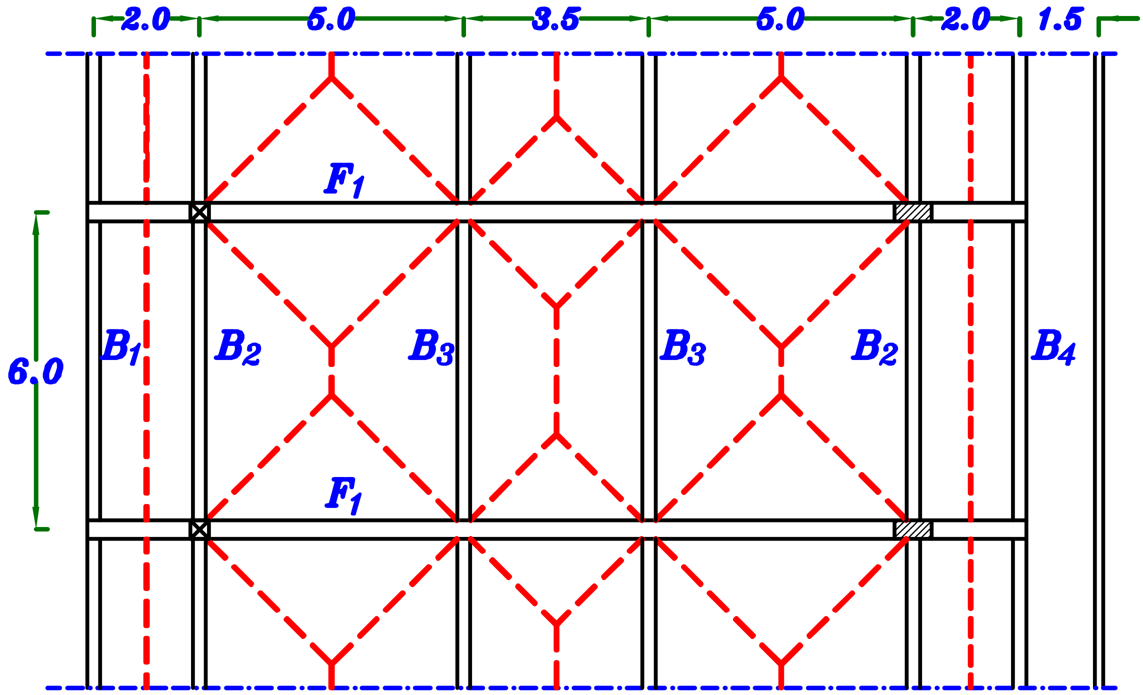
$$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 2.0 = 5.0\ kN\backslash m^2$$

$$p_s = L.L. = 2.50\ kN\backslash m^2$$

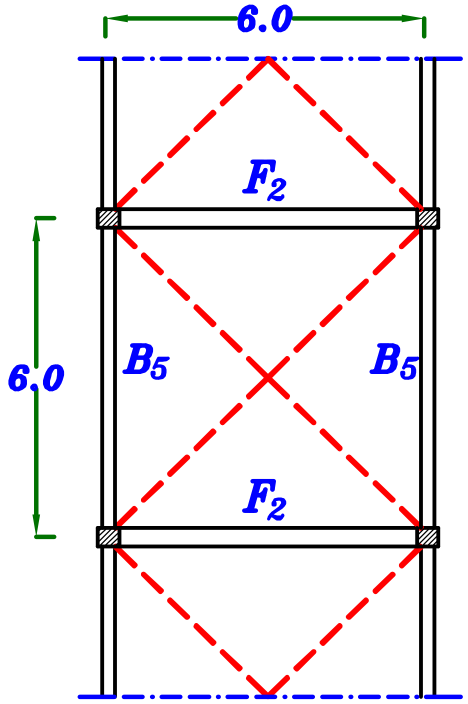
$$\boxed{g_s = 5.0\ kN\backslash m^2}\ ,\ \boxed{p_s = 2.50\ kN\backslash m^2}$$

2 – Draw plans ① & ② illustrate the pattern of load distribution.



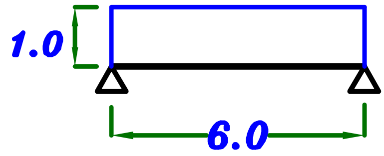


Plan ①



Plan ②

B_1



$$g_a = O.W. + g_s \frac{L_s}{2} = 3.12 + (5.0)\left(\frac{2}{2}\right) = 8.12 \ kN\backslash m^{`}$$

$$p_a = p_s \frac{L_s}{2} = (2.50)\left(\frac{2}{2}\right) = 2.50 \ kN\backslash m^{`}$$

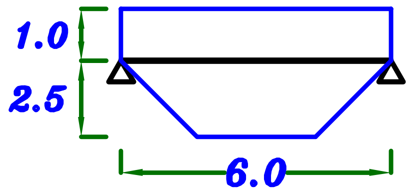
$$w_a = g_a + p_a = 8.12 + 2.50 = 10.62 \ kN\backslash m^{`}$$

$$R_1 = g_a * Spacing = 8.12 * 6.0 = 48.72 \ kN \text{ ---- D.L.}$$

$$= w_a * Spacing = 10.62 * 6.0 = 63.72 \ kN \text{ ---- T.L.}$$

$$\boxed{\begin{aligned} R_1 &= 48.72 \ kN \text{ ---- D.L.} \\ &= 63.72 \ kN \text{ ---- T.L.} \end{aligned}}$$

B_2



For Trapezoid $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5}{6}\right) = 0.583$

$$g_a = O.W. + g_s \frac{L_s}{2} + C_a \, g_s \frac{L_s}{2} = 3.12 + (5.0)\left(\frac{2}{2}\right) + 0.583\,(5.0)\left(\frac{5}{2}\right) = 15.4 \ kN\backslash m^{`}$$

$$p_a = p_s \frac{L_s}{2} + C_a \, p_s \frac{L_s}{2} = (2.50)\left(\frac{2}{2}\right) + 0.583\,(2.50)\left(\frac{5}{2}\right) = 6.14 \ kN\backslash m^{`}$$

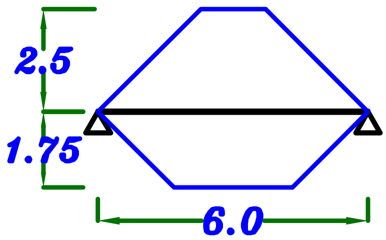
$$w_a = g_a + p_a = 15.4 + 6.14 = 21.54 \ kN\backslash m^{`}$$

$$R_2 = g_a * Spacing = 15.4 * 6.0 = 92.40 \ kN \text{ ---- D.L.}$$

$$= w_a * Spacing = 21.54 * 6.0 = 129.2 \ kN \text{ ---- T.L.}$$

$$\boxed{\begin{aligned} R_2 &= 92.40 \ kN \text{ ---- D.L.} \\ &= 129.2 \ kN \text{ ---- T.L.} \end{aligned}}$$

B_3



For Trapezoid ① $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{5}{6}\right) = 0.583$

For Trapezoid ② $C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.5}{6}\right) = 0.708$

$$g_a = O.W. + C_a \, g_s \frac{L_s}{2} + C_a \, g_s \frac{L_s}{2} = 3.12 + 0.583\,(5.0)\left(\frac{5}{2}\right) + 0.708\,(5.0)\left(\frac{3.5}{2}\right) = 16.6 \ kN\backslash m^{`}$$

$$p_a = C_a \, p_s \frac{L_s}{2} + C_a \, p_s \frac{L_s}{2} = 0.583\,(2.50)\left(\frac{5}{2}\right) + 0.708\,(2.50)\left(\frac{3.5}{2}\right) = 6.74 \ kN\backslash m^{`}$$

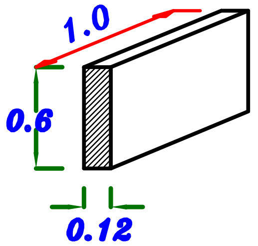
$$w_a = g_a + p_a = 16.6 + 6.74 = 23.34 \ kN\backslash m^{`}$$

$$R_3 = g_a * Spacing = 16.6 * 6.0 = 99.6 \ kN \text{ ---- D.L.}$$

$$= w_a * Spacing = 23.34 * 6.0 = 140 \ kN \text{ ---- T.L.}$$

$$\boxed{\begin{aligned} R_3 &= 99.6 \ kN \text{ ---- D.L.} \\ &= 140 \ kN \text{ ---- T.L.} \end{aligned}}$$

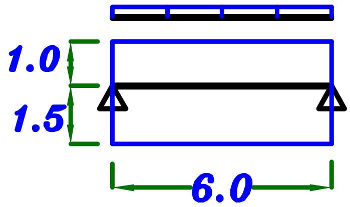
B_4



O.W. of the Fence $= (0.12)(0.6)(1.0)(25) = 1.80 \ kN\backslash m$

$$g_a = O.W.(beam) + O.W.(Fence) + g_s \frac{L_s}{2} + g_s L_c$$

$$= 3.12 + 1.80 + (5.0)\left(\frac{2}{2}\right) + (5.0)(1.5) = 17.42 \ kN\backslash m`$$



$$p_a = p_s \frac{L_s}{2} + p_s L_c = (2.50)\left(\frac{2}{2}\right) + (2.50)(1.5) = 6.25 \ kN\backslash m`$$

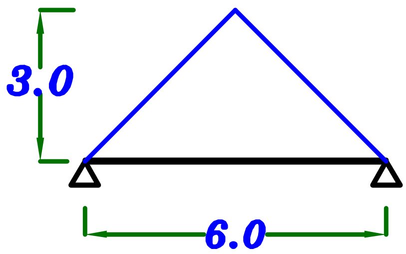
$$w_a = g_a + p_a = 17.42 + 6.25 = 23.67 \ kN\backslash m`$$

$$R_4 = g_a * Spacing = 17.42 * 6.0 = 104.5 \ kN \text{------ D.L.}$$

$$= w_a * Spacing = 23.67 * 6.0 = 142.0 \ kN \text{------ T.L.}$$

$$\boxed{\begin{aligned} R_4 &= 104.5 \ kN \text{------ D.L.} \\ &= 142.0 \ kN \text{------ T.L.} \end{aligned}}$$

B_5



For Triangle

$$C_a = \frac{1}{2} \ , \ C_e = \frac{2}{3}$$

$$g_a = O.W. + C_a \, g_s \frac{L_s}{2} = 3.12 + \left(\frac{1}{2}\right)(5.0)\left(\frac{6.0}{2}\right) = 10.6 \ kN\backslash m`$$

$$p_a = C_a \, p_s \frac{L_s}{2} = \left(\frac{1}{2}\right)(2.50)\left(\frac{6.0}{2}\right) = 3.75 \ kN\backslash m`$$

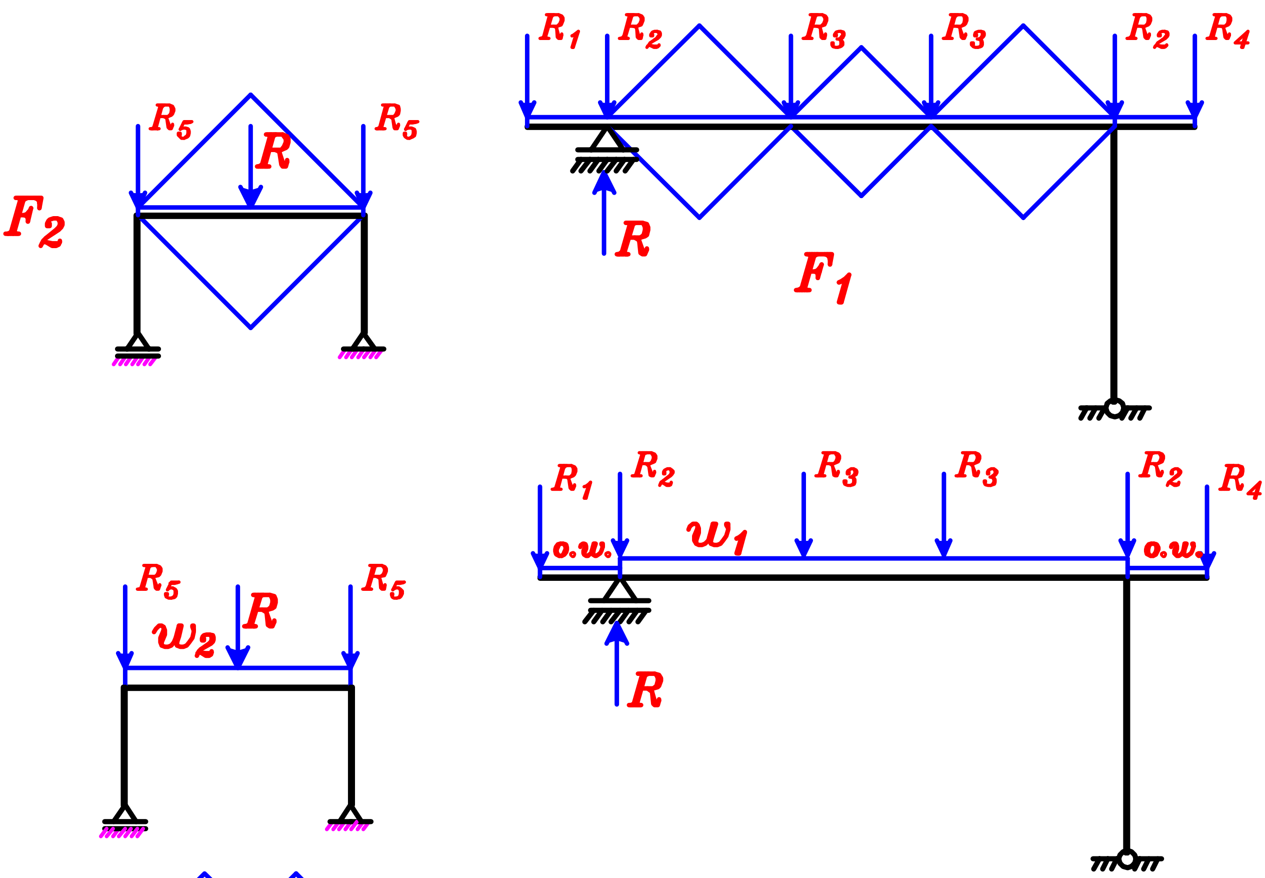
$$w_a = g_a + p_a = 10.6 + 3.75 = 14.35 \ kN\backslash m`$$

$$R_5 = g_a * Spacing = 10.6 * 6.0 = 63.6 \ kN \text{------ D.L.}$$

$$= w_a * Spacing = 14.35 * 6.0 = 86.1 \ kN \text{------ T.L.}$$

$$\boxed{\begin{aligned} R_5 &= 63.6 \ kN \text{------ D.L.} \\ &= 86.1 \ kN \text{------ T.L.} \end{aligned}}$$

Loads on the Frame.



$$\frac{\sum area}{span} = \frac{4\left(\frac{1}{2}\right)(5.0)\,(2.5) + 2\left(\frac{1}{2}\right)(3.5)\,(1.75)}{13.5} = 2.305$$

w_1 **Load For shear = Load For Moment**

$$g_1 = O.W. + \frac{\sum area}{span} * g_s = 10.0 + (2.305)\,(5.0) = 21.52 \ kN\backslash m`$$

$$p_1 = \frac{\sum area}{span} * p_s = (2.305)\,(2.50) = 5.76 \ kN\backslash m`$$

$$w_1 = g_1 + p_1 = 21.52 + 5.76 = 27.28 \ kN\backslash m`$$

w_2

$$g_a = O.W. + 2\, C_a\, g_s\, \frac{L_s}{2} = 5.25 + 2\left(\frac{1}{2}\right)(5.0)\left(\frac{6}{2}\right) = 20.25 \ kN\backslash m`$$

$$p_a = 2\, C_a\, p_s\, \frac{L_s}{2} = 2\left(\frac{1}{2}\right)(2.50)\left(\frac{6}{2}\right) = 7.50 \ kN\backslash m`$$

$$w_a = g_a + p_a = 20.25 + 7.50 = 27.75 \ kN\backslash m`$$

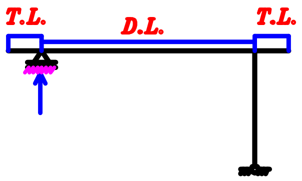
$$g_e = O.W. + 2\, C_e\, g_s\, \frac{L_s}{2} = 5.25 + 2\left(\frac{2}{3}\right)(5.0)\left(\frac{6}{2}\right) = 25.25 \ kN\backslash m`$$

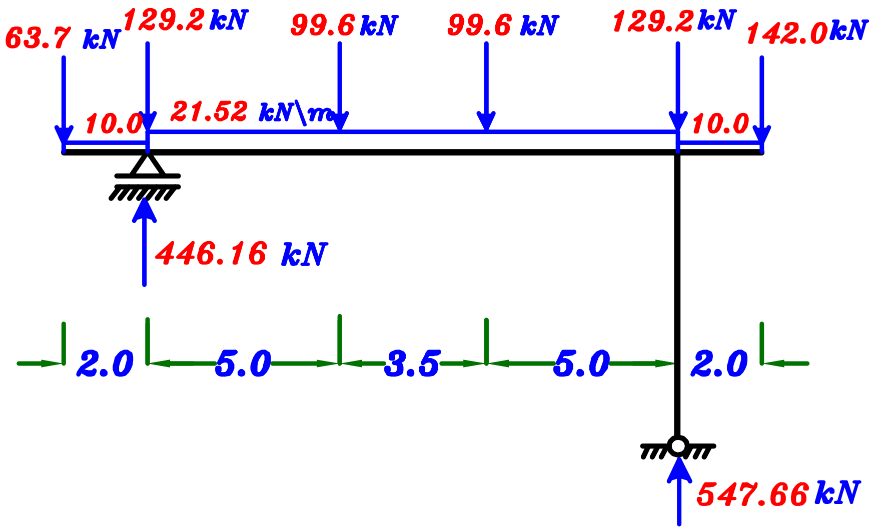
$$p_e = 2\, C_e\, p_s\, \frac{L_s}{2} = 2\left(\frac{2}{3}\right)(2.50)\left(\frac{6}{2}\right) = 10.0 \ kN\backslash m`$$

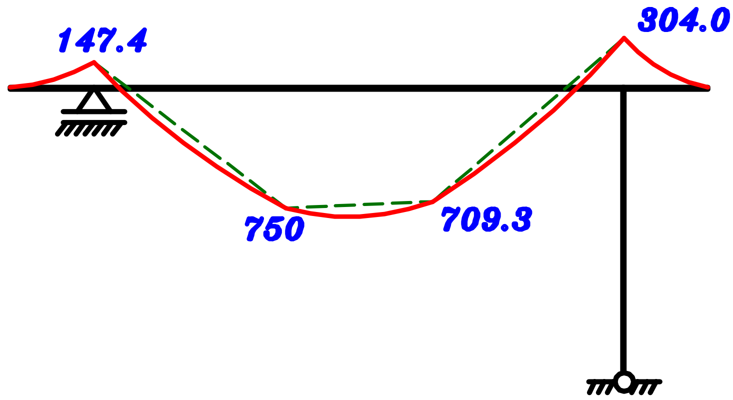
$$w_e = g_e + p_e = 25.35 + 10.0 = 35.25 \ kN\backslash m`$$

max-max B.M.D. on Frame (F_1)

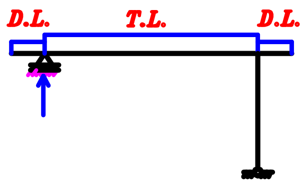
1- max. -ve B.M.D.

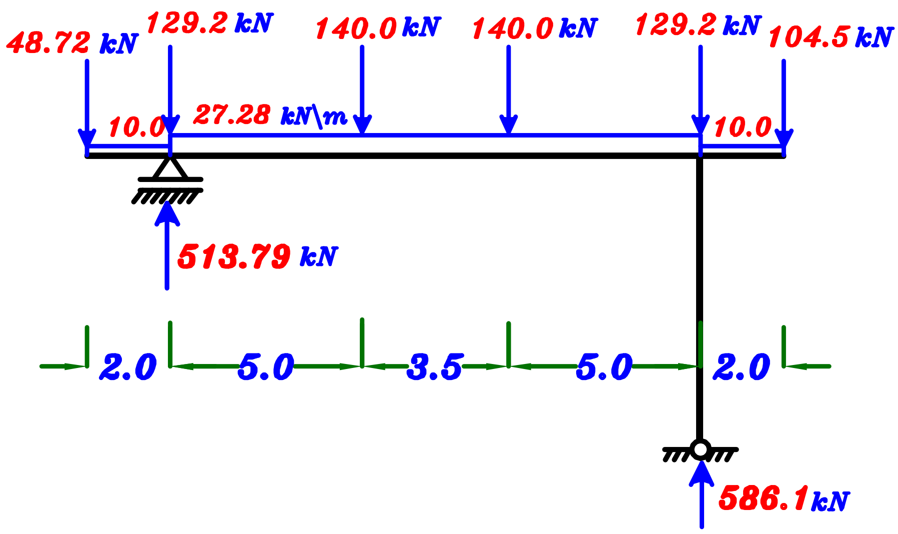


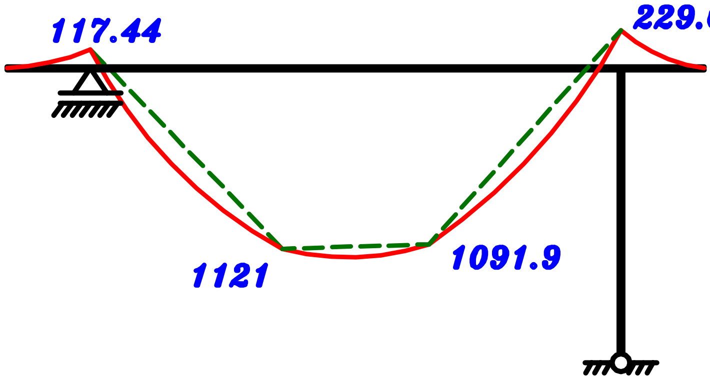




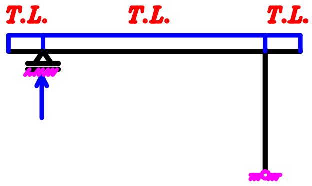
2- max. +ve B.M.D.

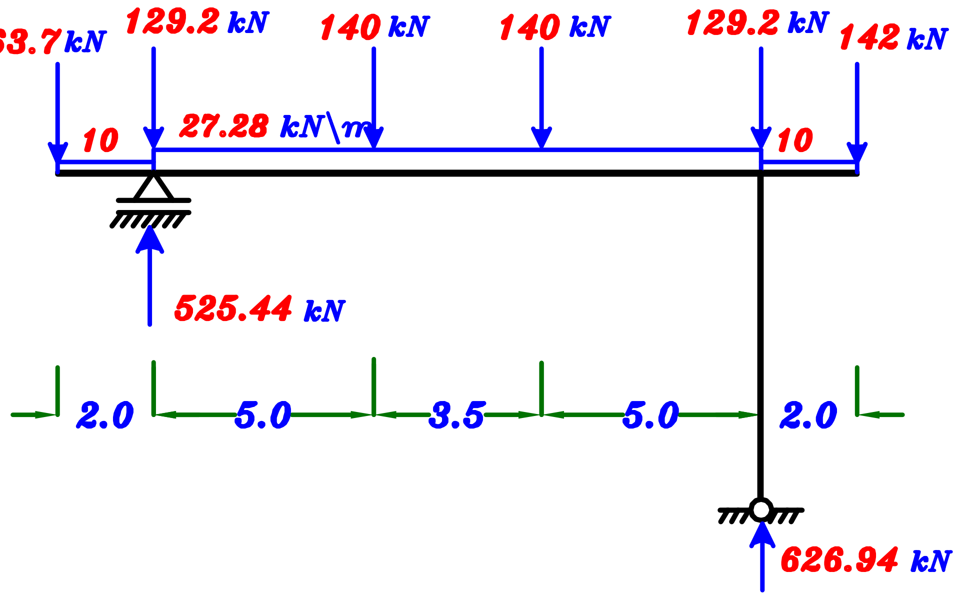




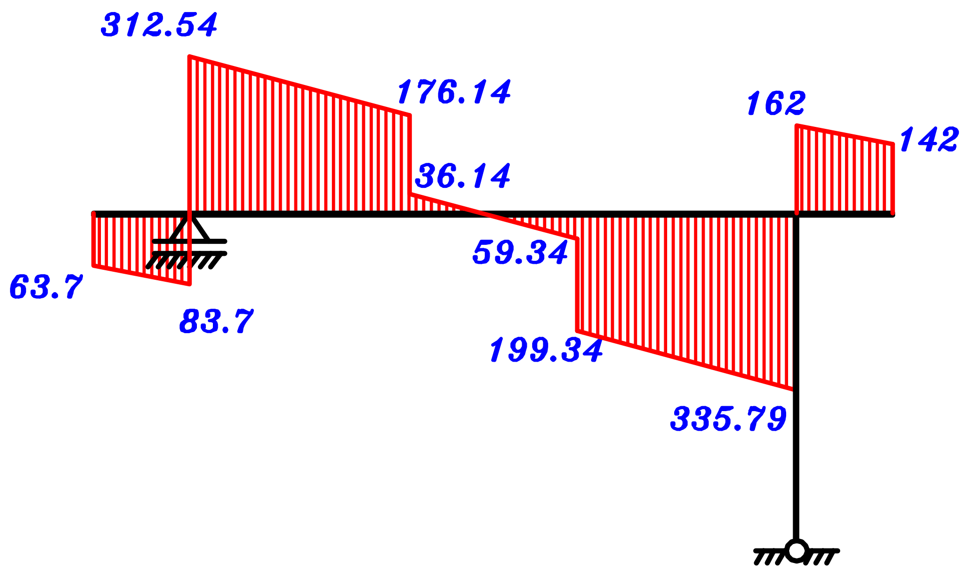


max−max S.F.D. & N.F.D. For Frame (F1)



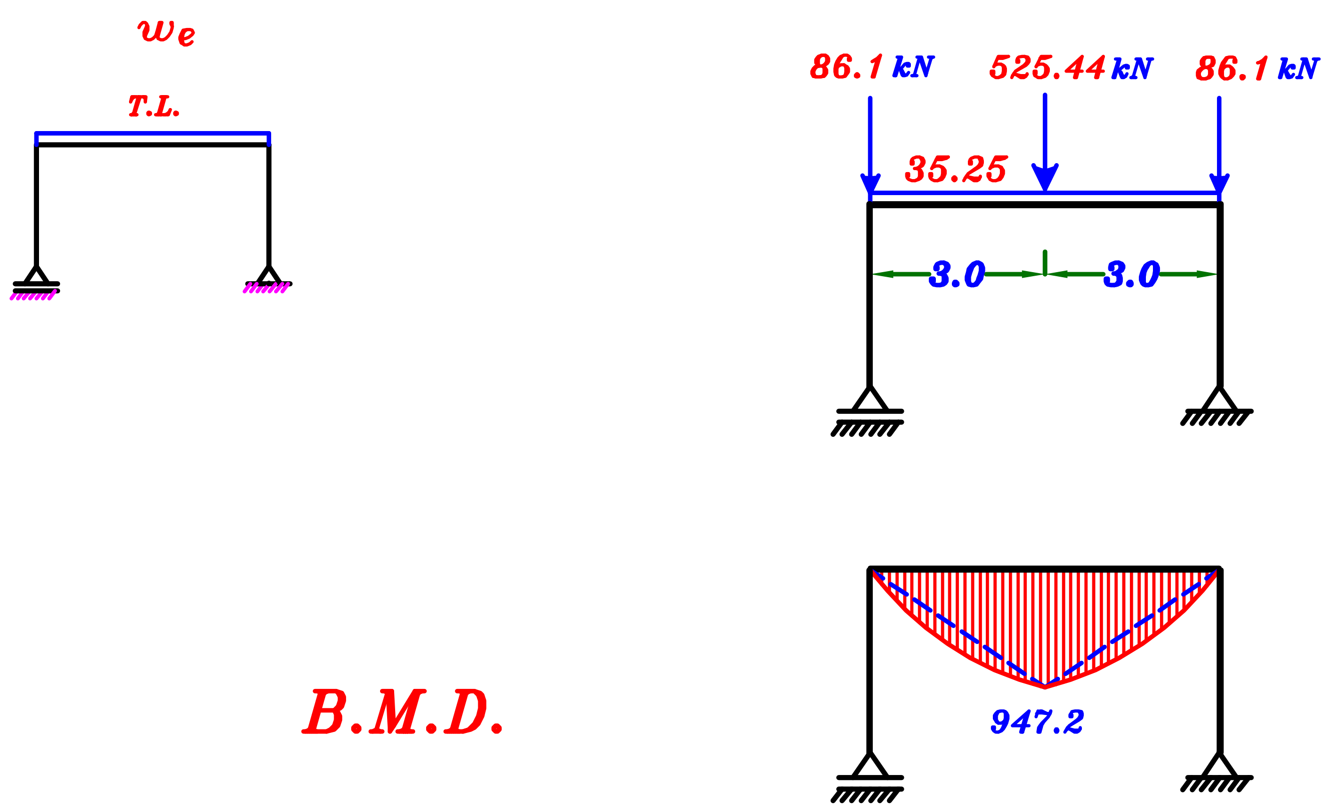


S.F.D.



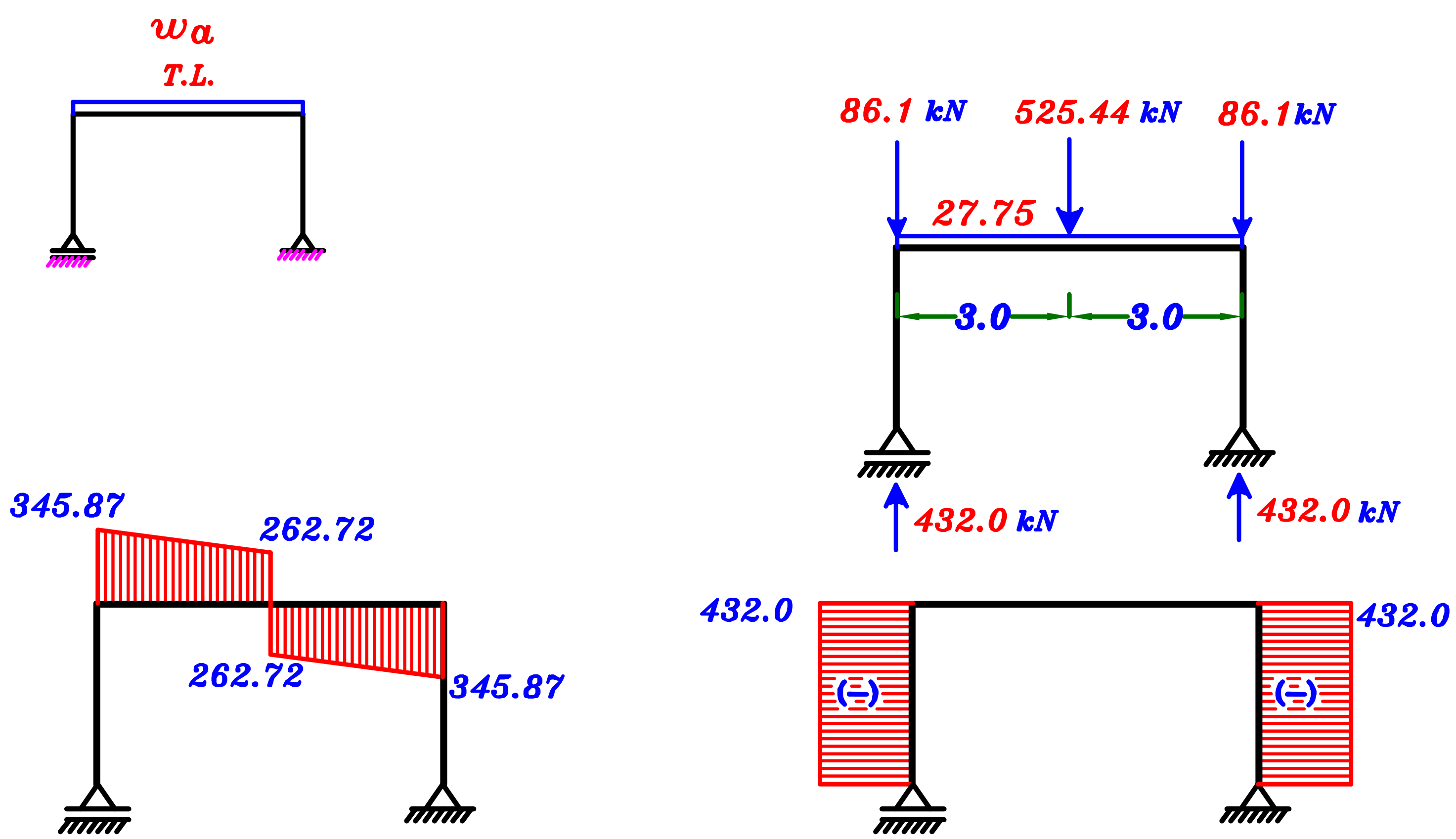
N.F.D.

max–max B.M.D. on Frame (F_2)



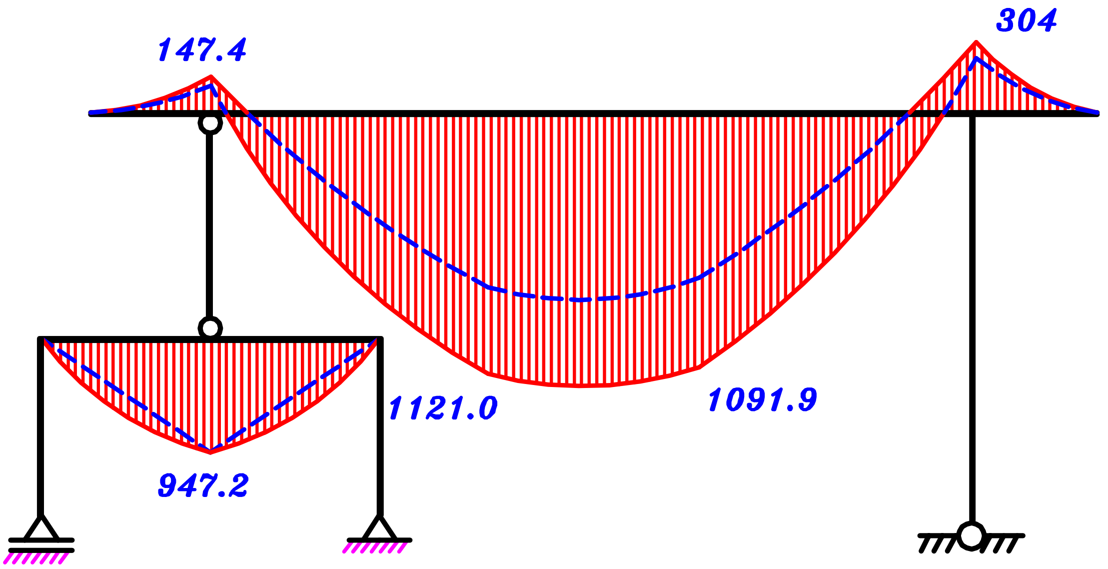
B.M.D.

max–max S.F.D. & N.F.D. For Frame (F_2)

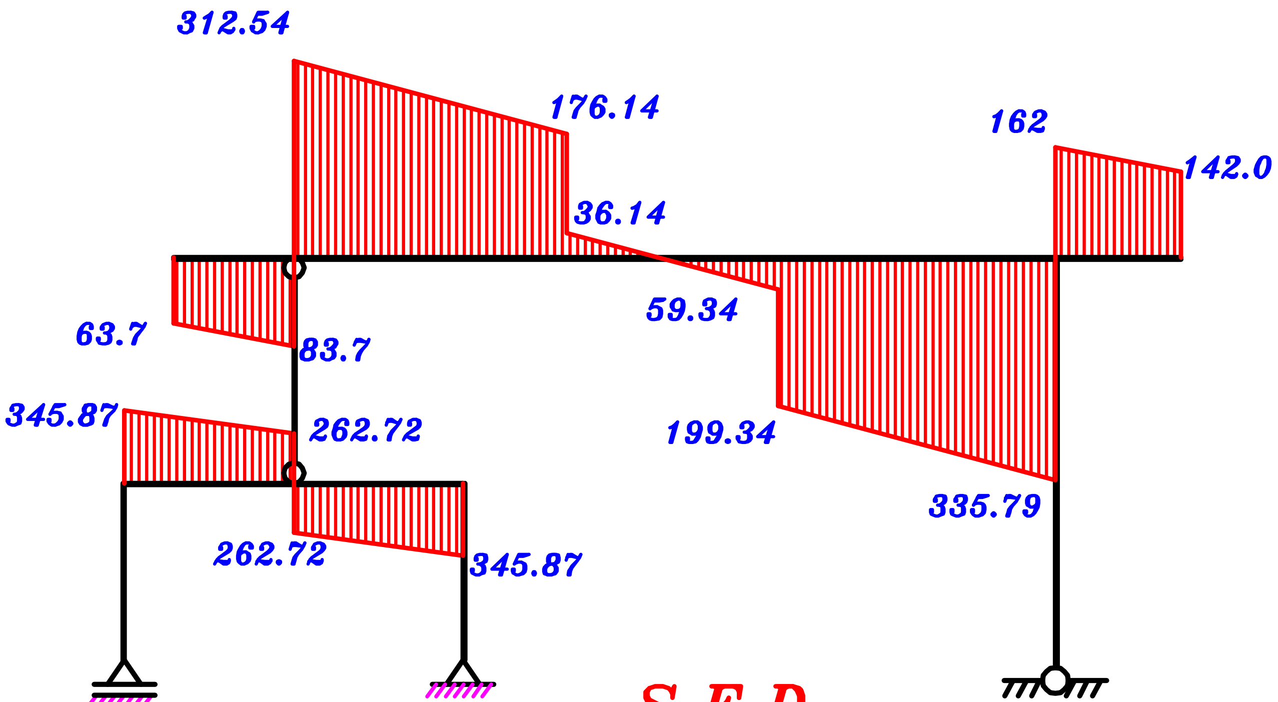


S.F.D.

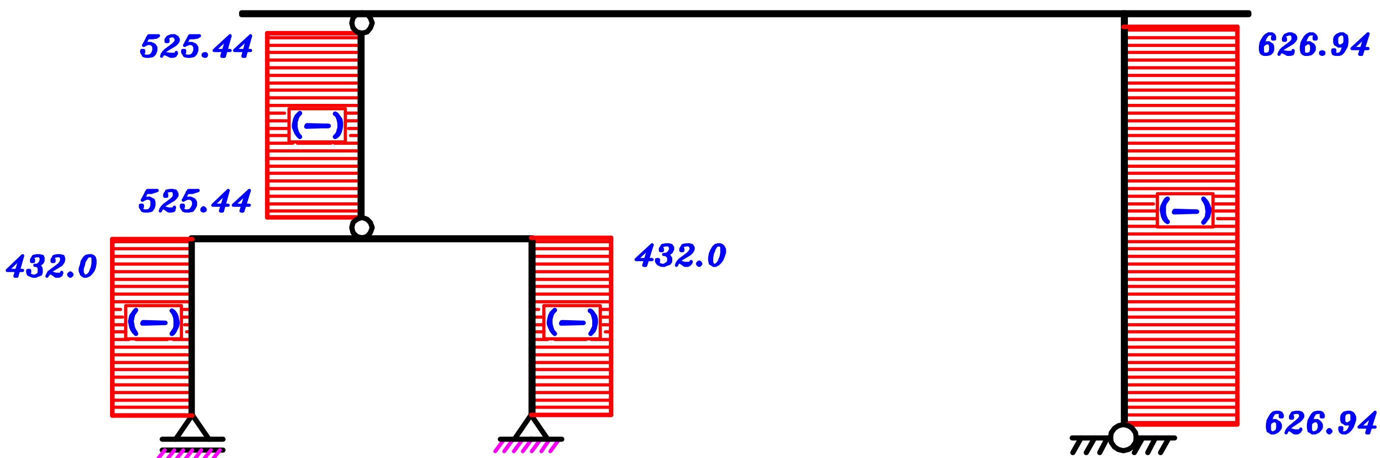
N.F.D.


147.4
304
1121.0
1091.9
947.2

B.M.D.


312.54
176.14
162
142.0
36.14
63.7
83.7
59.34
345.87
262.72
199.34
335.79
262.72
345.87

S.F.D.


525.44
(—)
525.44
432.0
(—)
(—)
432.0
626.94
(—)
626.94

N.F.D.

Example.

Figure 1 shows a sectional elevation of a reinforced concrete roof. The roof is covered by reinforced concrete slabs supported by a system of secondary beams and Frames (F) spaced at 6.0 m For an intermediate panel, it is required to :

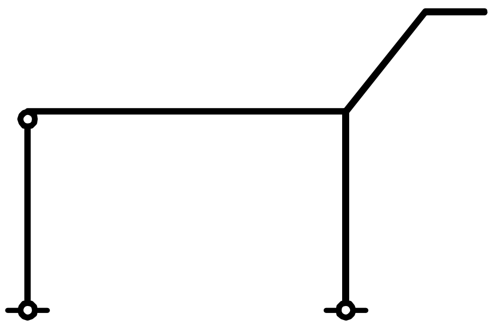
1 – Draw a structural plan showing the pattern of load distribution.

2 – Calculate the equivalent working loads For shear and moment For all secondary beams (B_1 , B_2 , B_3 , B_4 & B_5) and an intermediate Frame (F) .

3 – Draw the N.F.D. (total load) , S.F.D. (total load) and max–max B.M.D. For an intermediate Frame (F) , using ultimate limit loads.

Data:

- Slab thickness $t_s = 140$ mm
- Live load = 2.0 kN\m² HL. projection.
- Floor cover = 1.0 kN\m²
- Own weight of beams = 3.0 kN\m
- Own weight of Frame = 6.0 kN\m



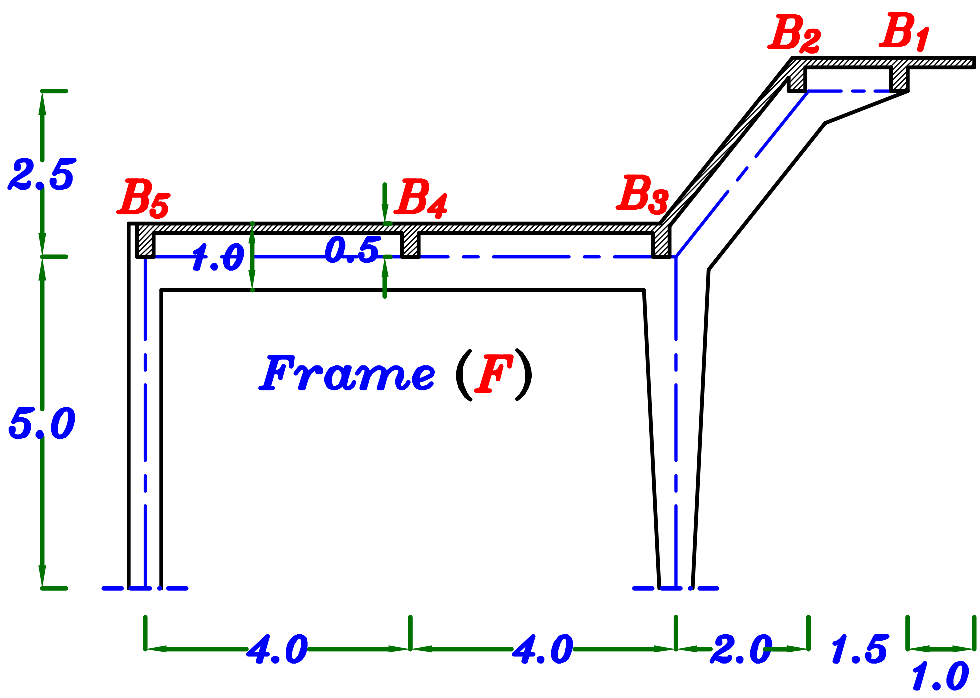


Figure 1

1 – Draw a structural plan showing the pattern of load distribution.

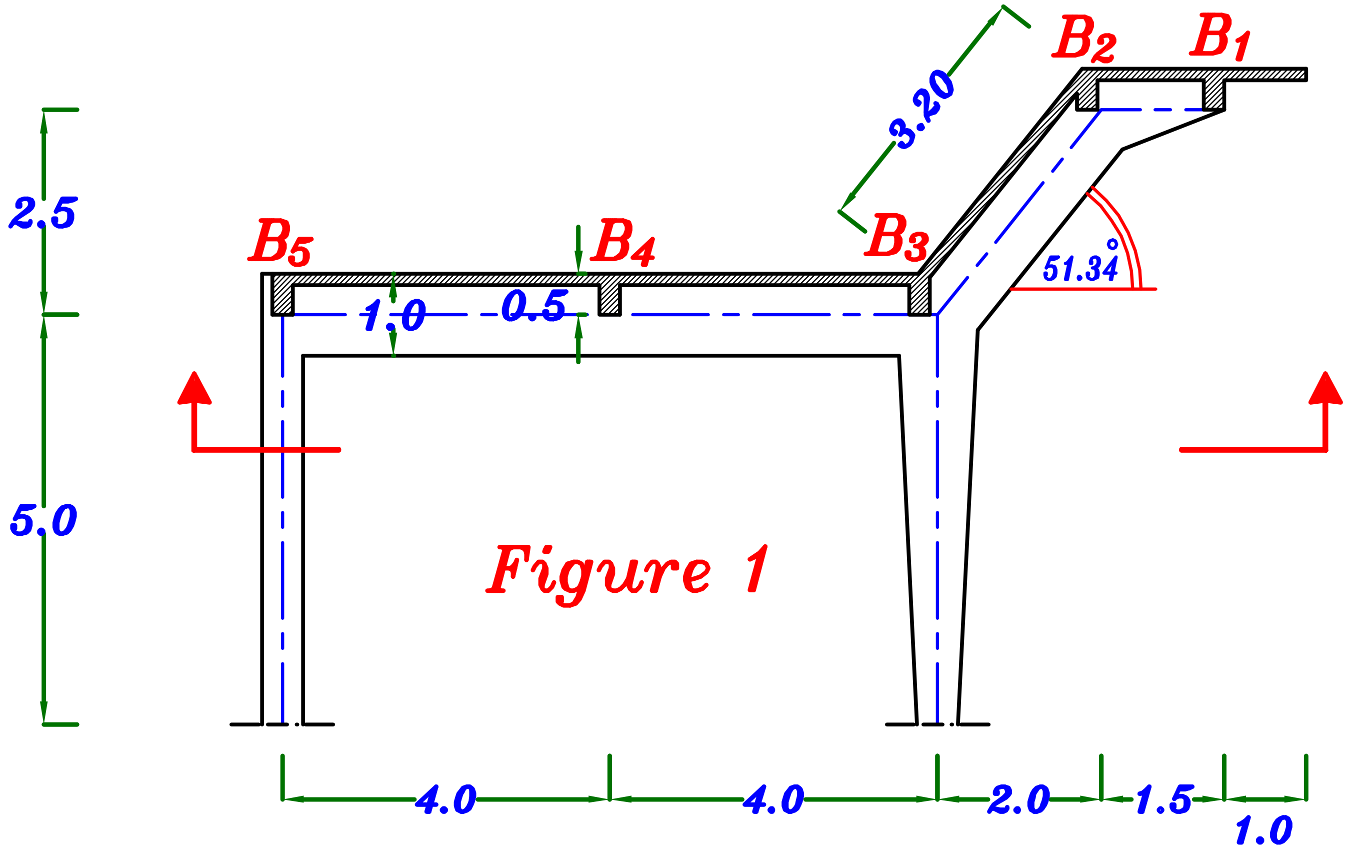
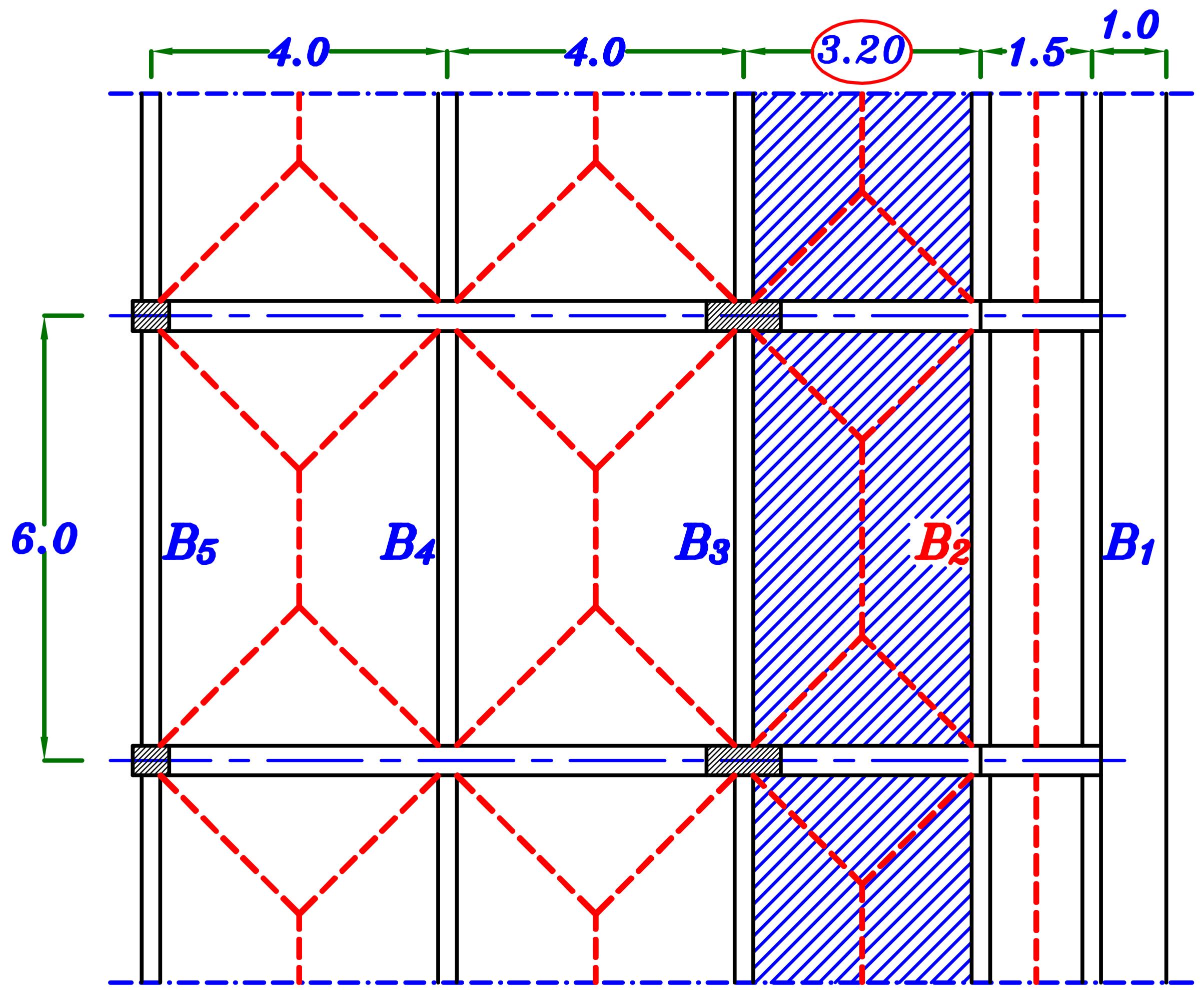


Figure 1



Plan

2- Calculate the equivalent working loads For shear and moment For all secondary beams (B_1, B_2, B_3, B_4 & B_5) and an intermediate Frame (F).

g_s , P_s

$$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 1.0 = 4.50 \ kN\backslash m^2$$

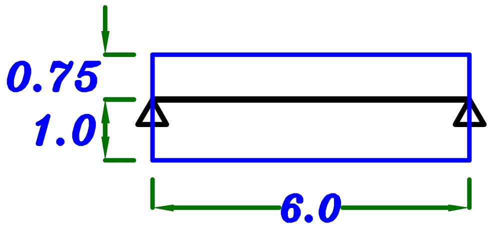
$$P_{sh} = L.L. = 2.0 \ kN\backslash m^2 \text{ ------ HL. Slab.}$$

$$P_{si} = L.L. * Cos\,\theta = 2.0 * Cos\,51.34^{\circ} = 1.25 \ kN\backslash m^2 \text{ ----- Inclined Slab.}$$

$$\boxed{g_s = 4.50 \ kN\backslash m^2} \ , \ \boxed{P_{sh} = 2.0 \ kN\backslash m^2} \ , \ \boxed{P_{si} = 1.25 \ kN\backslash m^2}$$

B_1

Load For Shear. = Load For Moment.



$$g_a = O.W. + g_s \frac{L_s}{2} + g_s L_c$$

$$= 3.0 + (4.50)\left(\frac{1.5}{2}\right) + (4.50)(1.0)$$

$$= 10.875 \ kN\backslash m'$$

$$P_a = P_{sh} \frac{L_s}{2} + P_{sh} L_c = (2.0)\left(\frac{1.5}{2}\right) + (2.0)(1.0) = 3.5 \ kN\backslash m'$$

$$w_a = g_a + P_a = 10.875 + 3.5 = 14.375 \ kN\backslash m'$$

$$R_1 = g_a * Spacing = 10.875 * 6.0 = 65.25 \ kN \text{ ----- D.L.}$$

$$= w_a * Spacing = 14.375 * 6.0 = 86.25 \ kN \text{ ----- T.L.}$$

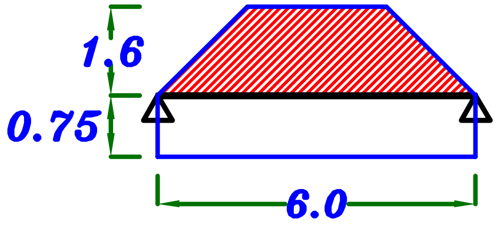
$$\boxed{\begin{aligned} R_1 &= 65.25 \ kN \text{ ---- D.L.} \\ &= 86.25 \ kN \text{ ---- T.L.} \end{aligned}}$$

B_2

For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.20}{6}\right) = 0.733$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.20}{6}\right)^2 = 0.905$$



Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + g_s \frac{L_s}{2}$$

$$= 3.0 + (0.733)(4.50)\left(\frac{3.2}{2}\right) + (4.50)\left(\frac{1.5}{2}\right) = 11.65 \text{ kN\m`}$$

$$p_a = C_a\, p_{si} \frac{L_s}{2} + p_{sh} \frac{L_s}{2} = (0.733)(1.25)\left(\frac{3.2}{2}\right) + (2.0)\left(\frac{1.5}{2}\right) = 2.96 \text{ kN\m`}$$

$$w_a = g_a + p_a = 11.65 + 2.96 = 14.61 \text{ kN\m`}$$

$$R_2 = g_a * Spacing = 11.65 * 6.0 = 69.9 \text{ kN} \text{ ------ D.L.}$$

$$= w_a * Spacing = 14.61 * 6.0 = 87.66 \text{ kN} \text{ ------ T.L.}$$

$$\boxed{\begin{aligned} R_2 &= 69.9 \text{ kN ---- D.L.} \\ &= 87.66 \text{ kN ---- T.L.} \end{aligned}}$$

Load For Moment.

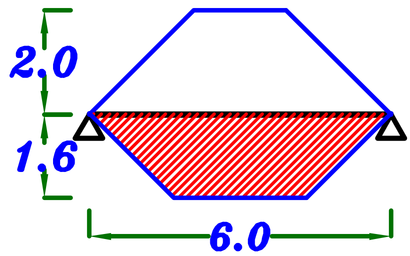
$$g_e = O.W. + C_e\, g_s \frac{L_s}{2} + g_s \frac{L_s}{2}$$

$$= 3.0 + (0.905)(4.50)\left(\frac{3.2}{2}\right) + (4.50)\left(\frac{1.5}{2}\right) = 12.89 \text{ kN\m`}$$

$$p_e = C_e\, p_{si} \frac{L_s}{2} + p_{sh} \frac{L_s}{2} = (0.905)(1.25)\left(\frac{3.2}{2}\right) + (2.0)\left(\frac{1.5}{2}\right) = 3.31 \text{ kN\m`}$$

$$w_e = g_e + p_e = 12.89 + 3.31 = 16.20 \text{ kN\m`}$$

B_3



For Trapezoid 1 Inclined

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{3.20}{6}\right) = 0.733$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{3.20}{6}\right)^2 = 0.905$$

For Trapezoid 2 H.L.

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{6}\right) = 0.67$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{6}\right)^2 = 0.85$$

Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} + C_a\, g_s \frac{L_s}{2}$$

$$= 3.0 + (0.733)(4.50)\left(\frac{3.2}{2}\right) + (0.67)(4.50)\left(\frac{4.0}{2}\right) = 14.30 \text{ kN}\backslash\text{m}$$

$$P_a = C_a\, P_{si} \frac{L_s}{2} + C_a P_{sh} \frac{L_s}{2} = (0.733)(1.25)\left(\frac{3.2}{2}\right) + (0.67)(2.0)\left(\frac{4.0}{2}\right) = 4.14 \text{ kN}\backslash\text{m}$$

$$w_a = g_a + P_a = 14.30 + 4.14 = 18.44 \text{ kN}\backslash\text{m}$$

$$R_3 = g_a * \text{Spacing} = 14.30 * 6.0 = 85.8 \text{ kN} \text{ ----- D.L.}$$

$$= w_a * \text{Spacing} = 18.44 * 6.0 = 110.64 \text{ kN} \text{ ----- T.L.}$$

$$\boxed{\begin{aligned} R_3 &= 85.8 \text{ kN --- D.L.} \\ &= 110.64 \text{ kN --- T.L.} \end{aligned}}$$

Load For Moment.

$$g_e = O.W. + C_e\, g_s \frac{L_s}{2} + C_e\, g_s \frac{L_s}{2}$$

$$= 3.0 + (0.905)(4.50)\left(\frac{3.2}{2}\right) + (0.85)(4.50)\left(\frac{4.0}{2}\right) = 17.16 \text{ kN}\backslash\text{m}$$

$$P_e = C_e\, P_{si} \frac{L_s}{2} + C_e P_{sh} \frac{L_s}{2} = (0.905)(1.25)\left(\frac{3.2}{2}\right) + (0.85)(2.0)\left(\frac{4.0}{2}\right) = 5.21 \text{ kN}\backslash\text{m}$$

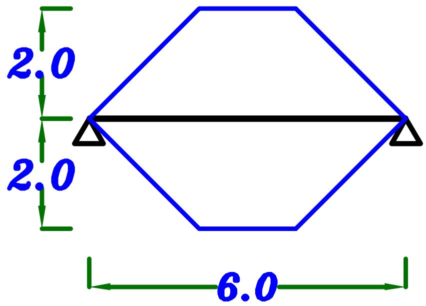
$$w_e = g_e + P_e = 17.16 + 5.21 = 22.37 \text{ kN}\backslash\text{m}$$

B_4

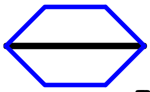
For Trapezoid 2 H.L.

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{6}\right) = 0.67$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{6}\right)^2 = 0.85$$



Load For Shear.



$$g_a = O.W. + 2\, C_a\, g_s\, \frac{L_s}{2} = 3.0 + 2\,(0.67)\,(4.50)\left(\frac{4.0}{2}\right) = 15.06\ kN\backslash m'$$

$$p_a = 2\, C_a\, p_{sh}\, \frac{L_s}{2} = 2\,(0.67)\,(2.0)\left(\frac{4.0}{2}\right) = 5.36\ kN\backslash m'$$

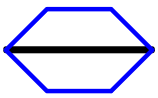
$$w_a = g_a + p_a = 15.06 + 5.36 = 20.42\ kN\backslash m'$$

$$R_4 = g_a * Spacing = 15.06 * 6.0 = 90.36\ kN \text{ ----- } D.L.$$

$$= w_a * Spacing = 20.42 * 6.0 = 122.52\ kN \text{ ----- } T.L.$$

$$\boxed{\begin{aligned} R_4 &= 90.36\ kN \text{ --- } D.L. \\ &= 122.52\ kN \text{ --- } T.L. \end{aligned}}$$

Load For Moment.



$$g_e = O.W. + 2\, C_e\, g_s\, \frac{L_s}{2} = 3.0 + 2\,(0.85)\,(4.50)\left(\frac{4.0}{2}\right) = 18.30\ kN\backslash m'$$

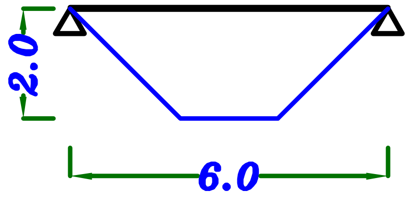
$$p_e = 2\, C_e\, p_{sh}\, \frac{L_s}{2} = 2\,(0.85)\,(2.0)\left(\frac{4.0}{2}\right) = 6.80\ kN\backslash m'$$

$$w_e = g_e + p_e = 18.30 + 6.80 = 25.10\ kN\backslash m'$$

B_5 For Trapezoid 2 H.L.

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.0}{6}\right) = 0.67$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.0}{6}\right)^2 = 0.85$$



Load For Shear.

$$g_a = O.W. + C_a\, g_s \frac{L_s}{2} = 3.0 + (0.67)(4.50)\left(\frac{4.0}{2}\right) = 9.03 \quad kN\backslash m'$$

$$p_a = C_a\, p_{sh} \frac{L_s}{2} = (0.67)(2.0)\left(\frac{4.0}{2}\right) = 2.68 \; kN\backslash m'$$

$$w_a = g_a + p_a = 9.03 + 2.68 = 11.71 \; kN\backslash m'$$

$$R_5 = g_a * Spacing = 9.03 * 6.0 = 54.18 \; kN \text{ ---- D.L.}$$

$$= w_a * Spacing = 11.71 * 6.0 = 70.26 \; kN \text{ ---- T.L.}$$

$$\boxed{\begin{aligned} R_5 &= 54.18 \; kN \text{ --- D.L.} \\ &= 70.26 \; kN \text{ ---- T.L.} \end{aligned}}$$

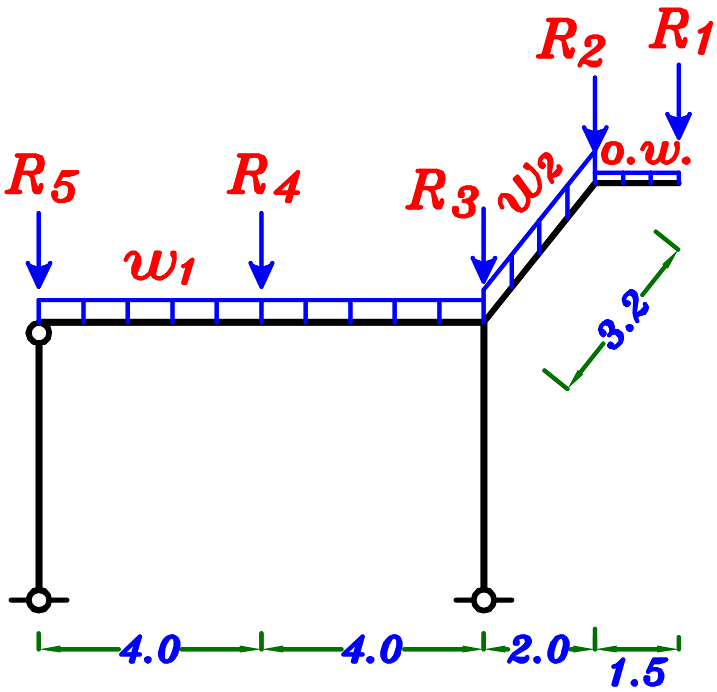
Load For Moment.

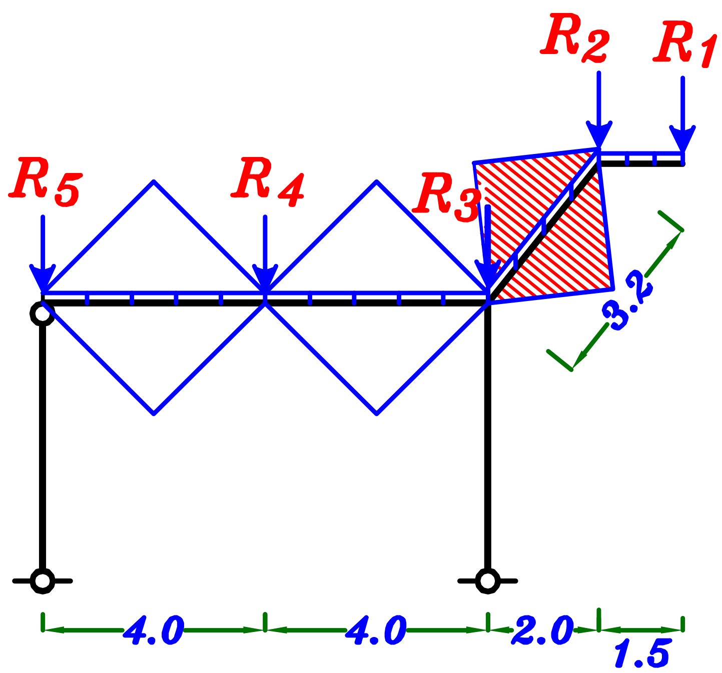
$$g_e = O.W. + C_e\, g_s \frac{L_s}{2} = 3.0 + (0.85)(4.50)\left(\frac{4.0}{2}\right) = 10.65 \; kN\backslash m'$$

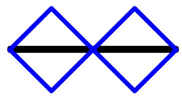
$$p_e = C_e\, p_{sh} \frac{L_s}{2} = (0.85)(2.0)\left(\frac{4.0}{2}\right) = 3.40 \; kN\backslash m'$$

$$w_e = g_e + p_e = 10.65 + 3.40 = 14.05 \; kN\backslash m'$$

3- Draw the N.F.D. (total load), S.F.D. (total load) and max-max B.M.D. For an intermediate Frame (F), using ultimate limit loads.







w_1

$$\frac{\sum area}{span} = \frac{4\left(\frac{1}{2}(4.0)(2.0)\right)}{8.0} = 2.0$$

$$g_{1a} = g_{1e} = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (2.0)(4.50) = 15.0 \ kN\backslash m'$$

$$p_{1a} = p_{1e} = \frac{\sum area}{span} * p_{sh} = (2.0)(2.0) = 4.0 \ kN\backslash m'$$

$$w_{1a} = w_{1e} = g_a + p_a = 15.0 + 4.0 = 19.0 \ kN\backslash m'$$

w_2

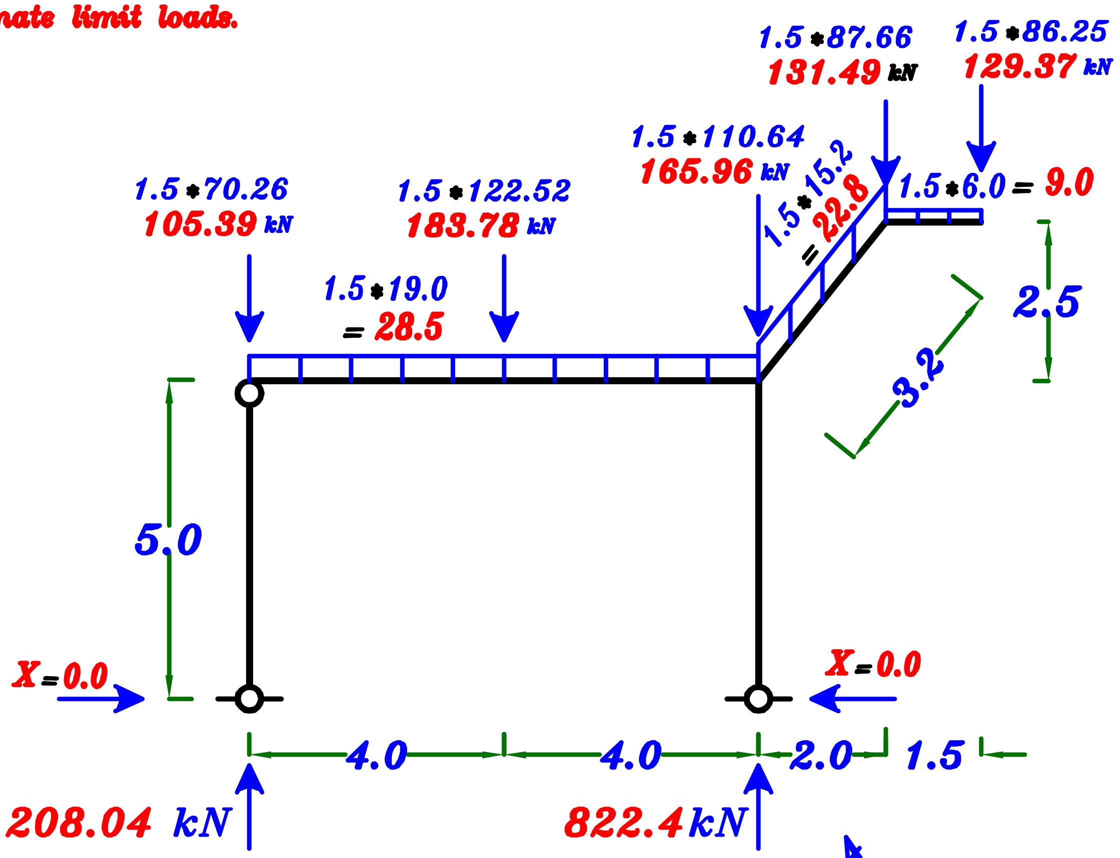
$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2}(3.2)(1.6)\right)}{3.2} = 1.60$$

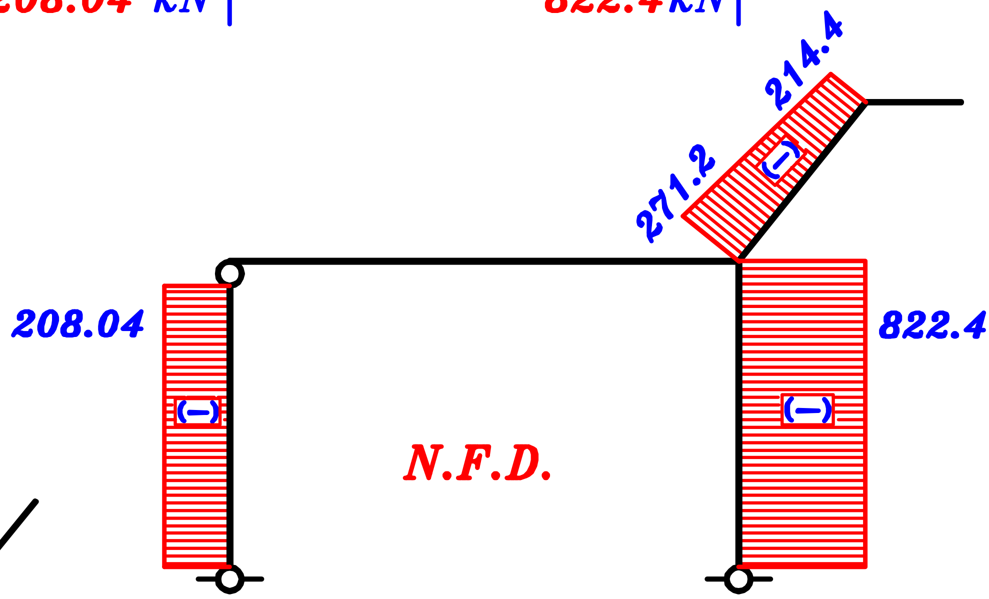
$$g_{2a} = g_{2e} = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.60)(4.50) = 13.2 \ kN\backslash m'$$

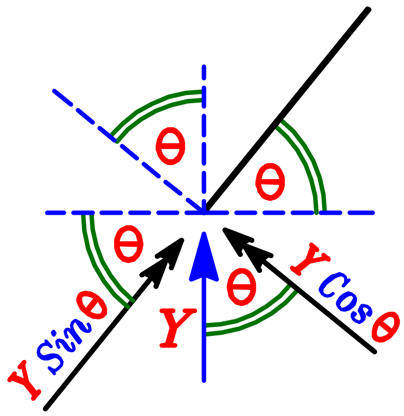
$$p_{2a} = p_{2e} = \frac{\sum area}{span} * p_{si} = (1.60)(1.25) = 2.0 \ kN\backslash m'$$

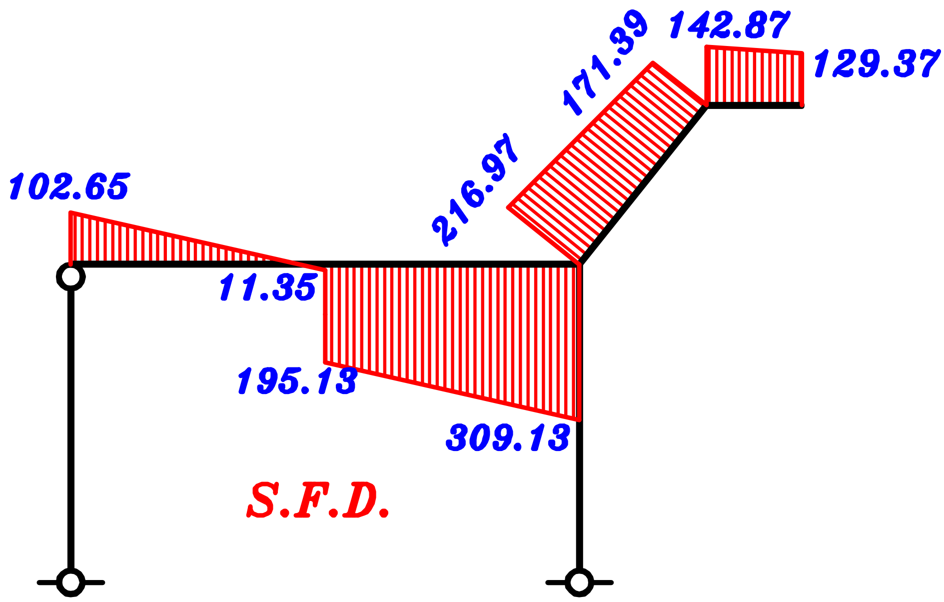
$$w_{2a} = w_{2e} = g_a + p_a = 13.2 + 2.0 = 15.2 \ kN\backslash m'$$

3- Draw the N.F.D. (total load), S.F.D. (total load) For an intermediate Frame (F) using ultimate limit loads.

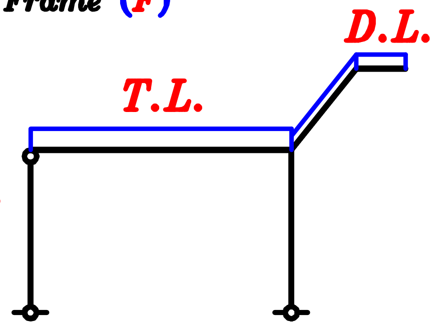




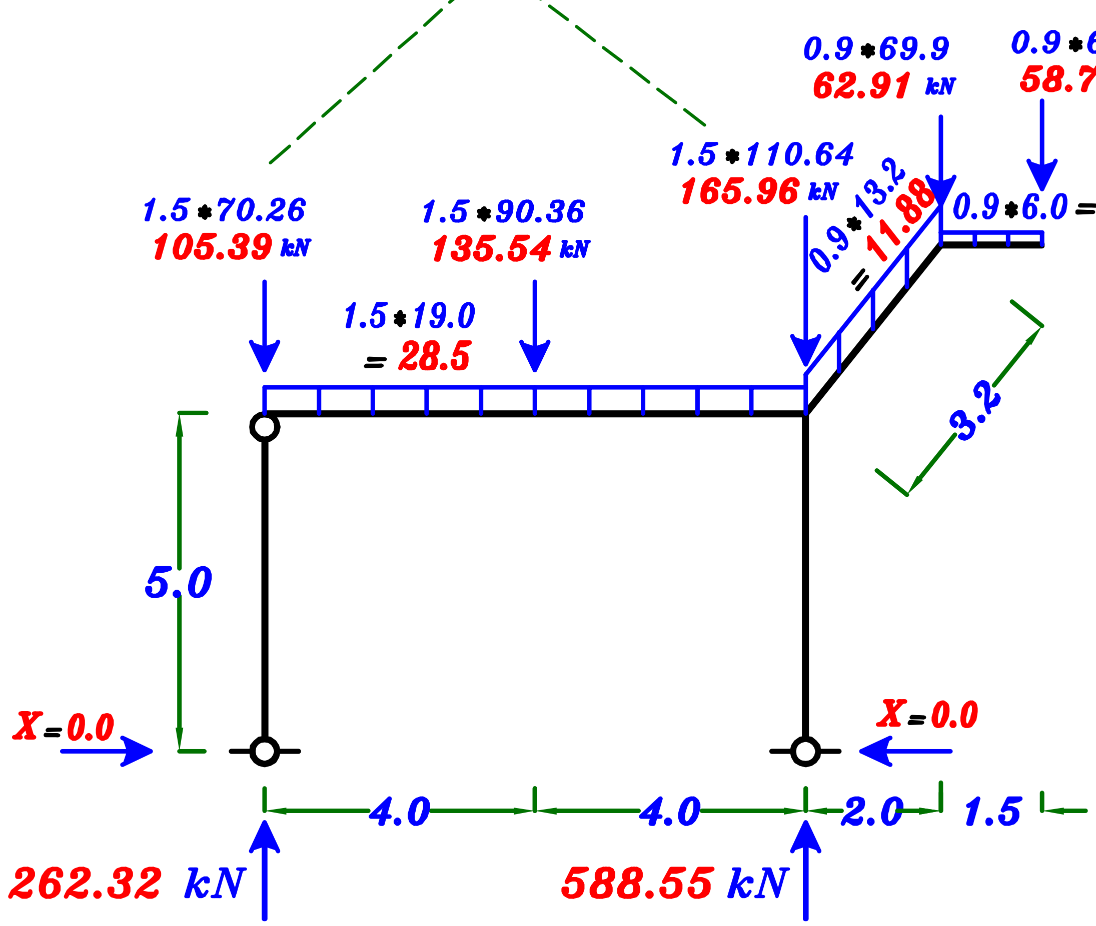


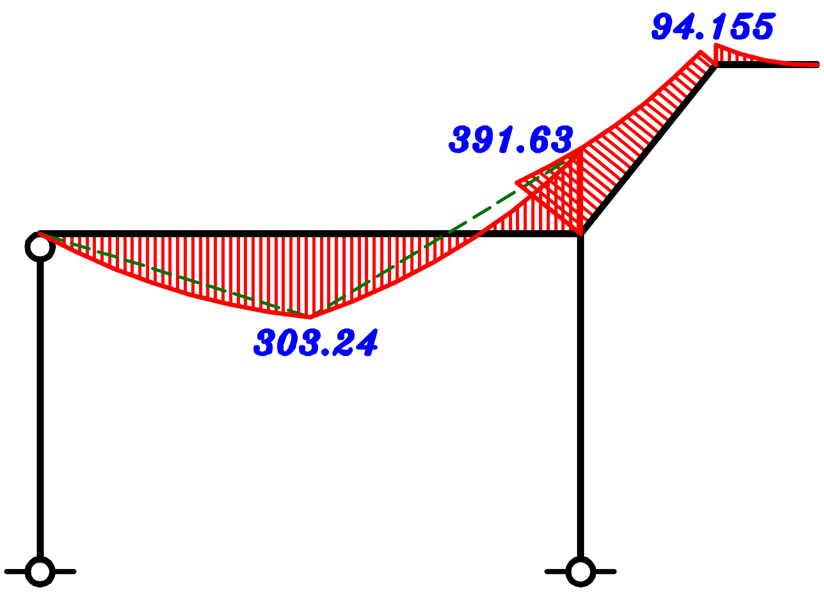


3- Draw the max–max B.M.D. For an intermediate Frame (F) using ultimate limit loads.



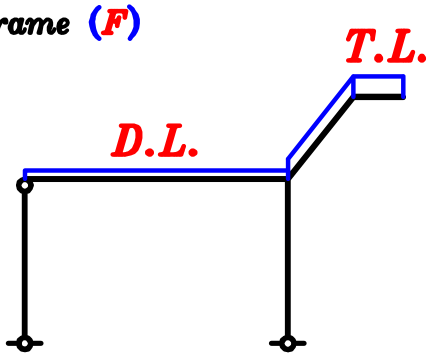
فى جميع حالات التحميل نأخذ الحمل
فوق العمود T.L. لانه لن يؤثر على عزم ال Frame
و لكنه سيزيد من ال Normal على العمود





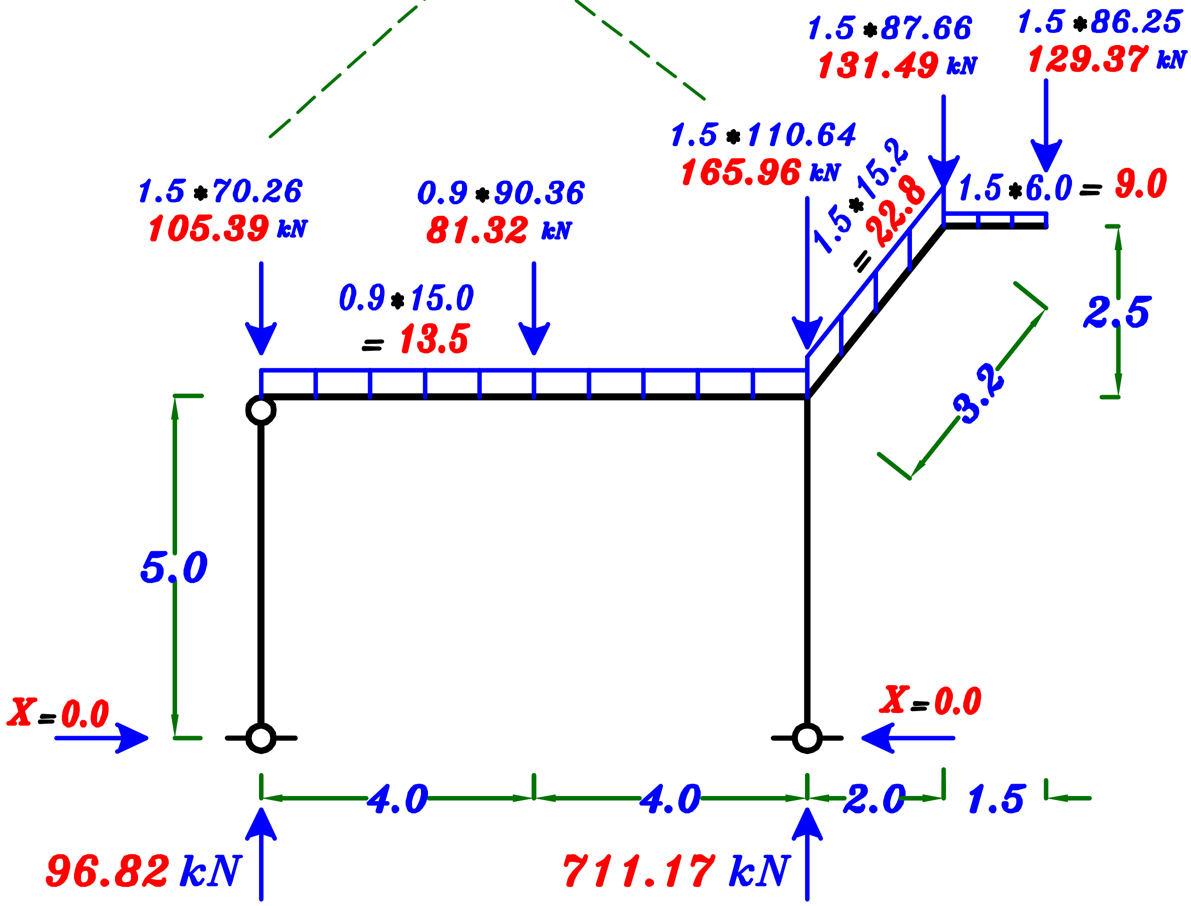
max (+Ve) B.M.D.

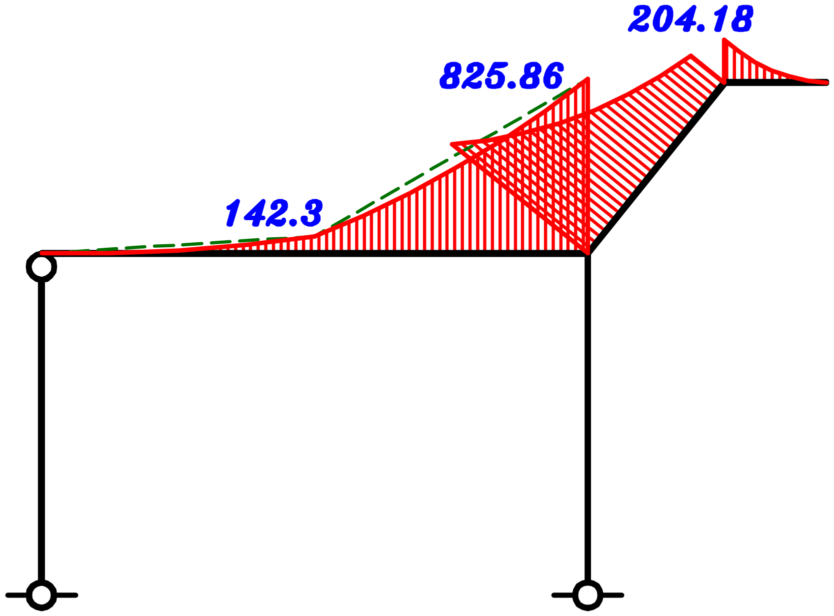
3- Draw the max-max B.M.D. For an intermediate Frame (F) using ultimate limit loads.



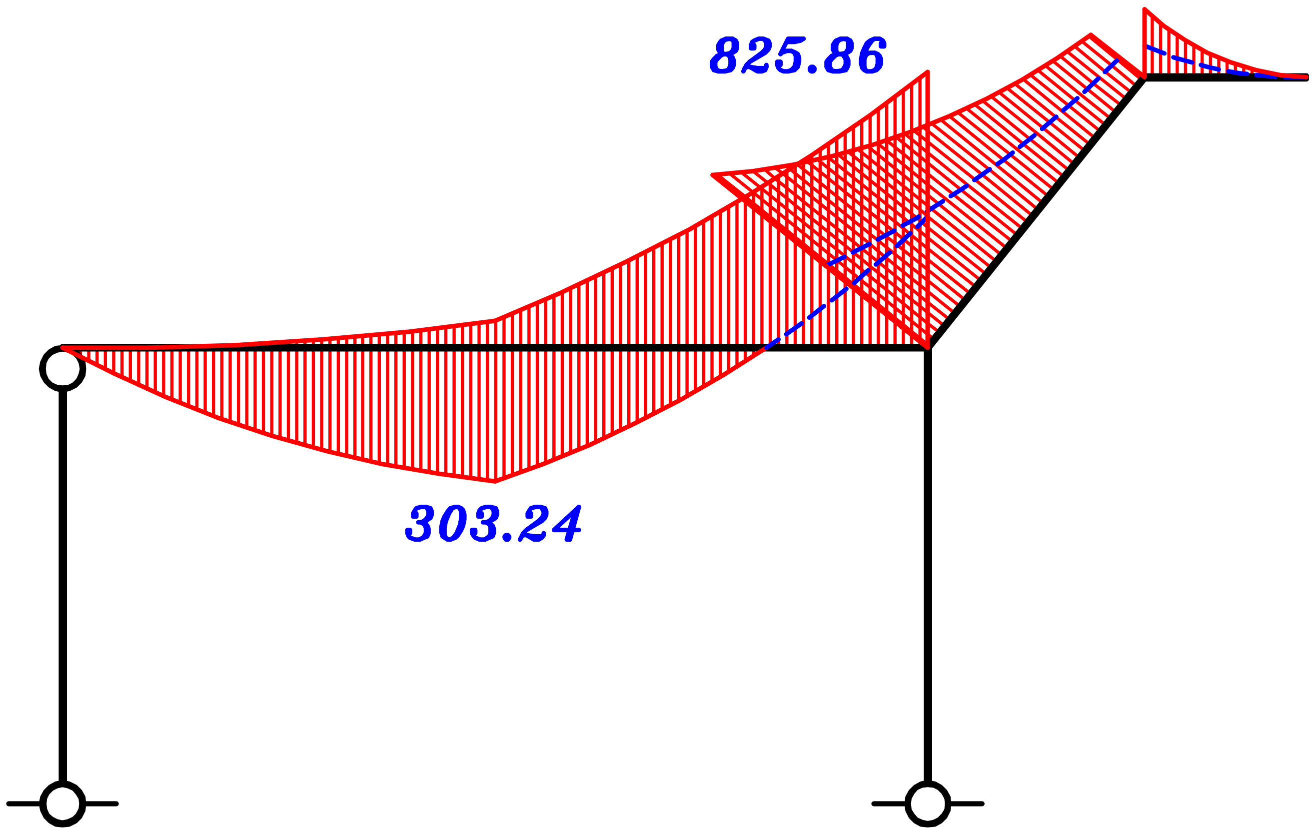
max (-Ve) B.M.D.

فى جميع حالات التحميل نأخذ الحمل
فوق العمود T.L. لانه لن يؤثر على عزم ال Frame
و لكنه سيزيد من ال Normal على العمود





max (-Ve) B.M.D.



max–max **B.M.D.**

Example.

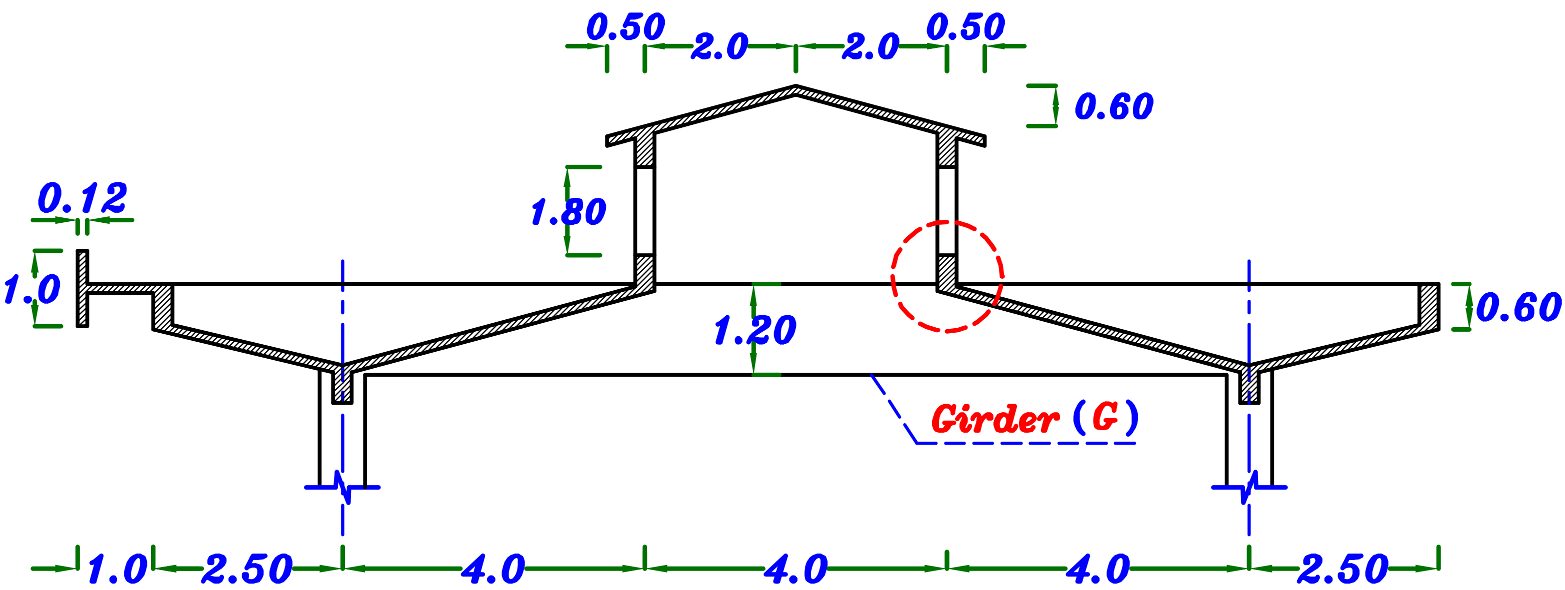


Figure 1

Figure 1 shows a sectional elevation of a reinforced concrete roof. The roof is covered by reinforced concrete slabs supported by a system of secondary beams. and Girders (G), spaced at 6.0 m.

It is required:

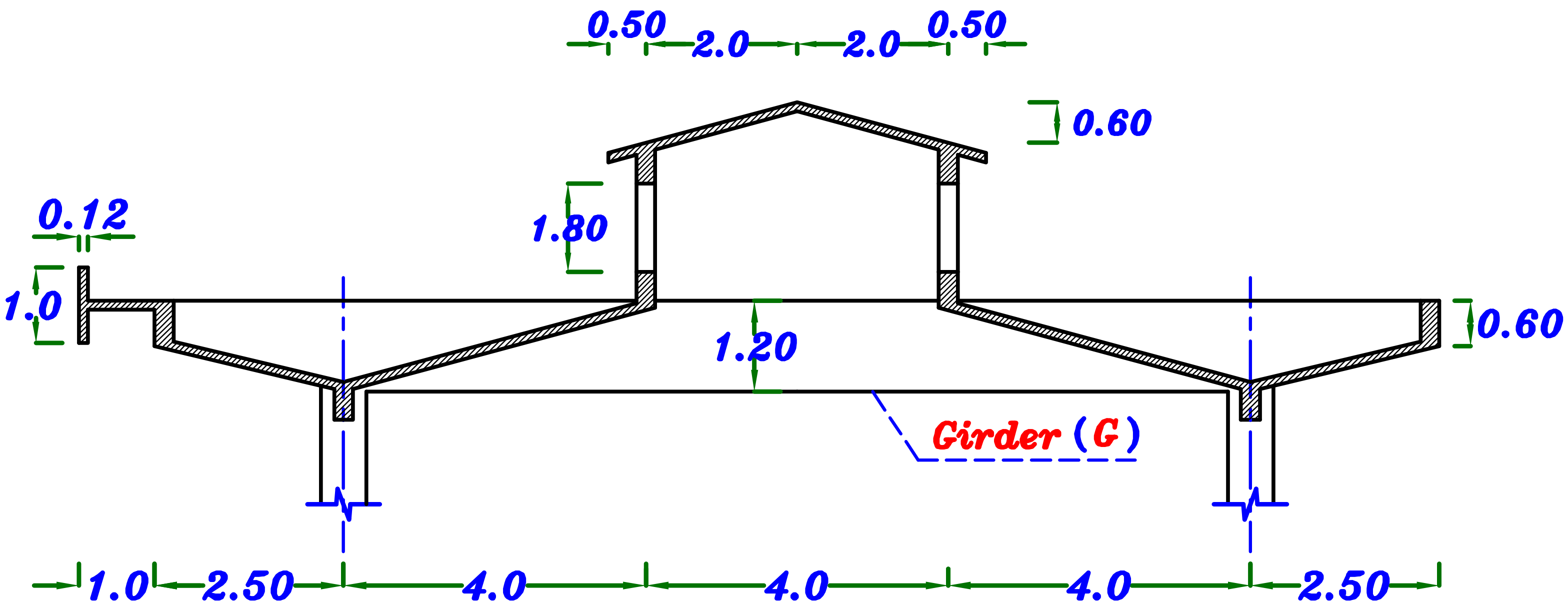
1- Draw a structural plan showing the pattern of load distribution.

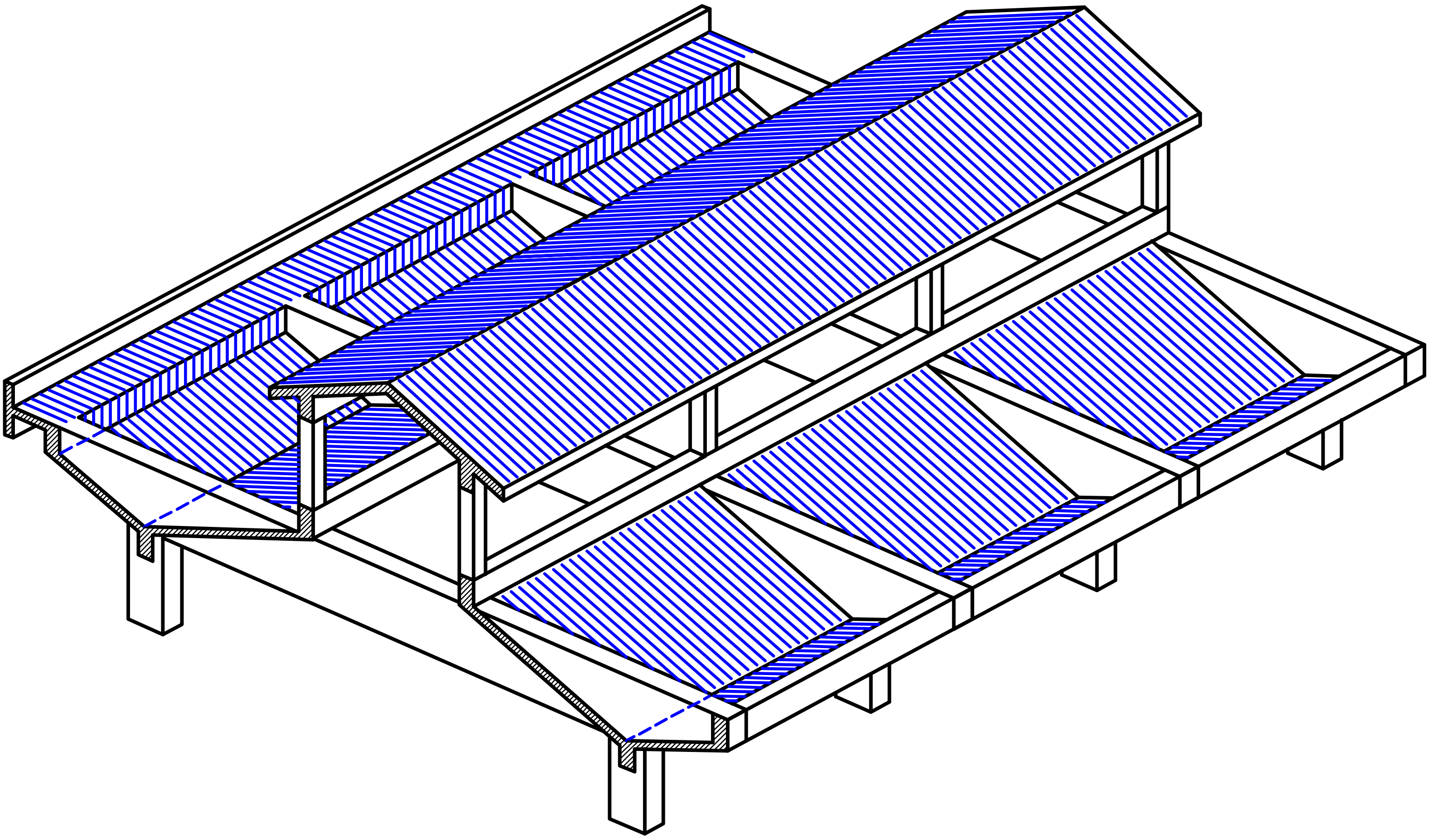
2- Calculate the equivalent working loads for shear and moment For an intermediate Girder (G).

3- Draw the S.F.D. (total loads) and max.-max. B.M.D. For an intermediate Girder (G). using ultimate limit loads.

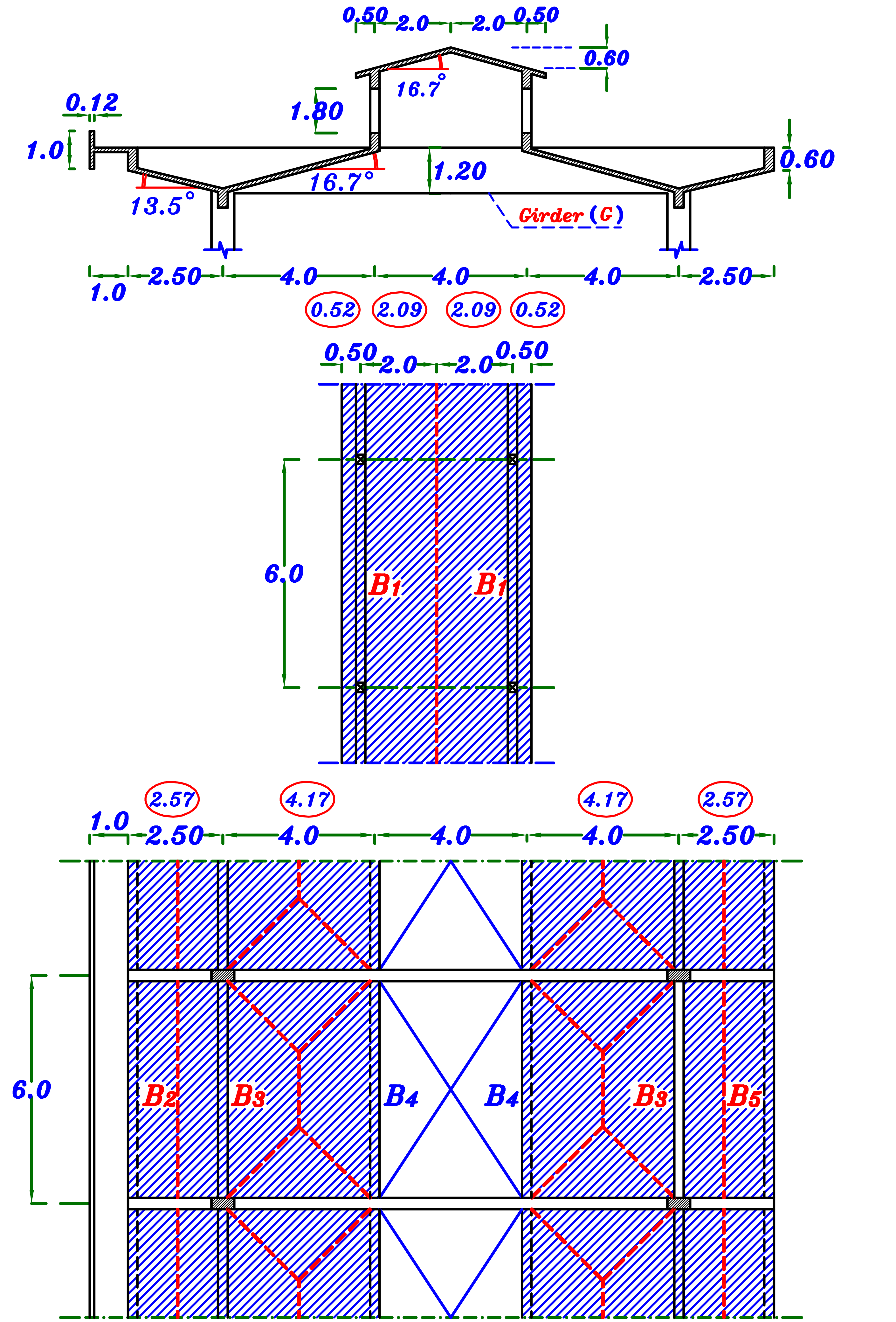
Data:

- Slab thickness $t_s = 120$ mm
- Live load $= 1.0$ kN\m^2
- Floor cover $= 1.5$ kN\m^2
- Breadth of all beams $= 250$ mm
- Breadth of all girders $= 300$ mm
- Own weight of beams $= 3.0$ kN\m
- Own weight of girders $= 6.0$ kN\m





ملحوظه هامه . البلاطه مائله لكن ال ***Girder*** أفقى


0.50
2.0
2.0
0.50
0.60
16.7°
0.12
1.80
1.0
0.60
1.20
16.7°
13.5°
Girder (G)
1.0
2.50
4.0
4.0
4.0
2.50
0.52
2.09
2.09
0.52
0.50
2.0
2.0
0.50
6.0
B1
B1
2.57
4.17
4.17
2.57
1.0
2.50
4.0
4.0
4.0
2.50
6.0
B2
B3
B4
B4
B3
B5

g_s, p_s

$$g_s = t_s * \gamma_c + F.C. = 0.12 * 25 + 1.50 = 4.50 \ kN\backslash m^2$$

$$p_{sh} = L.L. = 1.0 \ kN\backslash m^2$$ ------ HL. Slab.

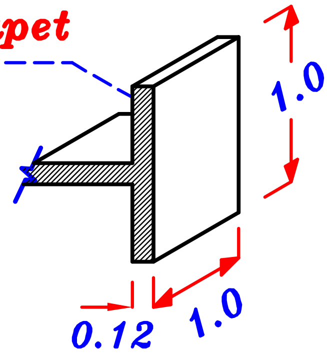
$$p_{si1} = L.L. * \cos\theta = 1.0 * \cos 16.7^\circ = 0.957 \ kN\backslash m^2$$ --- For Inclination 16.7°

$$p_{si2} = L.L. * \cos\theta = 1.0 * \cos 13.5^\circ = 0.972 \ kN\backslash m^2$$ --- For Inclination 13.5°

$\boxed{g_s = 4.50 \ kN\backslash m^2}$, $\boxed{p_{sh} = 1.0 \ kN\backslash m^2}$

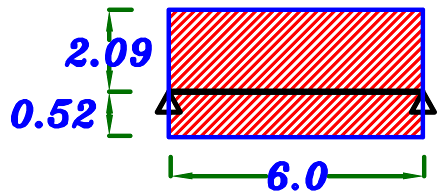
$\boxed{p_{si1} = 0.957 \ kN\backslash m^2}$, $\boxed{p_{si2} = 0.972 \ kN\backslash m^2}$

O.W. of parapet



O.W. of parapet $= (0.12)(1.0)(1.0)(25) = 3.0 \ kN\backslash m'$

B_1 Load For Shear.



$$g_a = o.w. + g_s \frac{L_s}{2} + g_s L_c$$

$$= 3.0 + (4.50)(2.09) + (4.50)(0.52) = 14.74 \ kN\backslash m'$$

$$p_a = p_{si1} \frac{L_s}{2} + p_{si1} L_c$$

$$= (0.957)(2.09) + (0.957)(0.52) = 2.49 \ kN\backslash m'$$

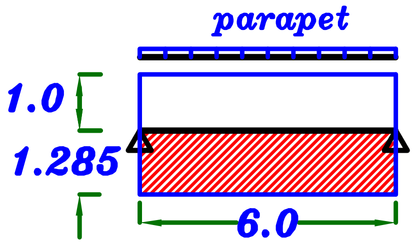
$$w_a = g_a + p_a = 14.74 + 2.49 = 17.23 \ kN\backslash m'$$

$R_1 = g_a * \text{Spacing} = 14.74 * 6.0 = 88.44 \ kN$ ------ D.L.

$= w_a * \text{Spacing} = 17.23 * 6.0 = 103.38 \ kN$ ------ T.L.

$$\boxed{\begin{aligned} R_1 &= 88.44 \ kN \text{ ------ D.L.} \\ &= 103.38 \ kN \text{ ------ T.L.} \end{aligned}}$$

B_2 Load For Shear.



$$g_a = o.w. + g_s \frac{L_s}{2} + g_s L_c + parapet$$

$$= 3.0 + (4.50)\left(\frac{2.57}{2}\right) + (4.50)(1.0) + 3.0 = 16.28 \ kN\backslash m'$$

$$p_a = p_{si2} \frac{L_s}{2} + p_{sh} L_c$$

$$= (0.972)\left(\frac{2.57}{2}\right) + (1.0)(1.0) = 2.25 \ kN\backslash m'$$

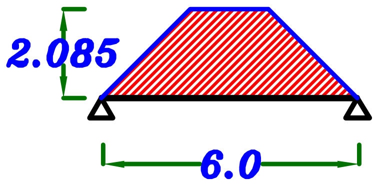
$$w_a = g_a + p_a = 16.28 + 2.25 = 18.53 \ kN\backslash m'$$

$$R_2 = g_a * Spacing = 16.28 * 6.0 = 97.68 \ kN \text{ ------ D.L.}$$

$$= w_a * Spacing = 18.53 * 6.0 = 111.18 \ kN \text{ ------ T.L.}$$

$$\boxed{\begin{aligned} R_2 &= 97.68 \ kN \text{ ----- D.L.} \\ &= 111.18 \ kN \text{ ----- T.L.} \end{aligned}}$$

B_4 For Trapezoid



$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.17}{6}\right) = 0.652$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.17}{6}\right)^2 = 0.839$$

Load For Shear.

$$g_a = o.w. + C_a g_s \frac{L_s}{2} = 3.0 + (0.652)(4.50)\left(\frac{4.17}{2}\right) = 9.12 \ kN\backslash m'$$

$$p_a = C_a p_{si1} \frac{L_s}{2} = (0.652)(0.957)\left(\frac{4.17}{2}\right) = 1.30 \ kN\backslash m'$$

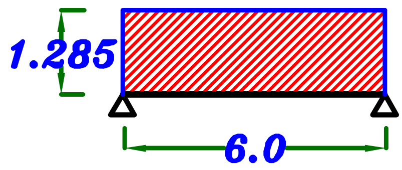
$$w_a = g_a + p_a = 9.12 + 1.30 = 10.42 \ kN\backslash m'$$

$$R_4 = g_a * Spacing = 9.12 * 6.0 = 54.72 \ kN \text{ ------ D.L.}$$

$$= w_a * Spacing = 10.42 * 6.0 = 62.52 \ kN \text{ ------ T.L.}$$

$$\boxed{\begin{aligned} R_4 &= 54.72 \ kN \text{ ------ D.L.} \\ &= 62.52 \ kN \text{ ------ T.L.} \end{aligned}}$$

B_5 Load For Shear.



$$g_a = o.w. + g_s \frac{L_s}{2} = 3.0 + (4.50)\left(\frac{2.57}{2}\right) = 8.78 \quad kN\backslash m`$$

$$p_a = p_{si2} \frac{L_s}{2} = (0.972)\left(\frac{2.57}{2}\right) = 1.25 \quad kN\backslash m`$$

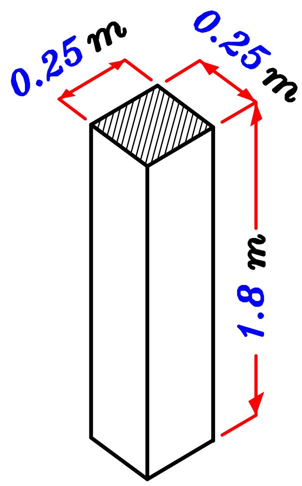
$$w_a = g_a + p_a = 8.78 + 1.25 = 10.03 \quad kN\backslash m`$$

$$R_5 = g_a * Spacing = 8.78 * 6.0 = 52.68 \quad kN \text{ ------ D.L.}$$

$$= w_a * Spacing = 10.03 * 6.0 = 60.18 \quad kN \text{ ------ T.L.}$$

$$\boxed{\begin{aligned} R_5 &= 52.68 \ kN \text{ ------ D.L.} \\ &= 60.18 \ kN \text{ ------ T.L.} \end{aligned}}$$

Post



Weight of the Post = Volume * Density

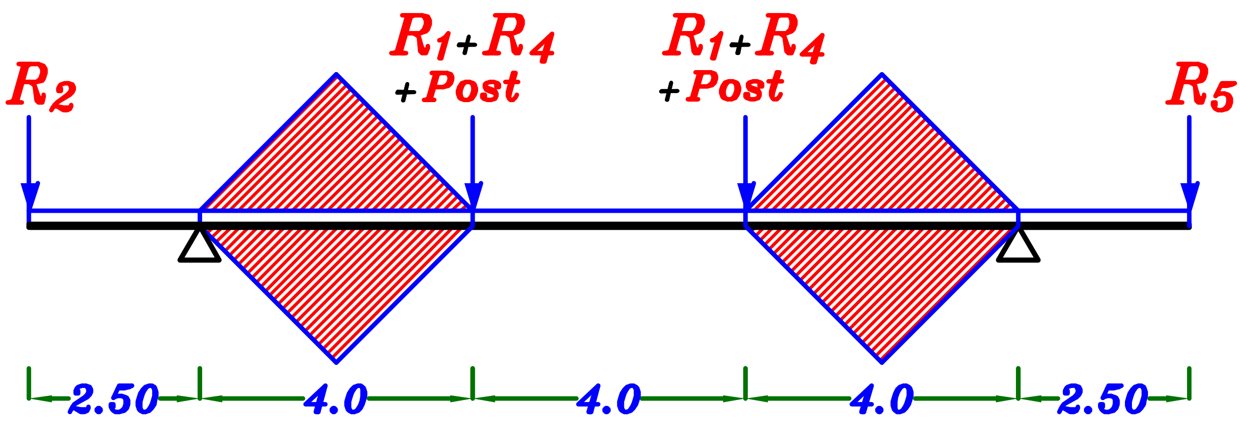
$$= (0.25 * 0.25 * 1.80)(25) = 2.81 \quad kN$$

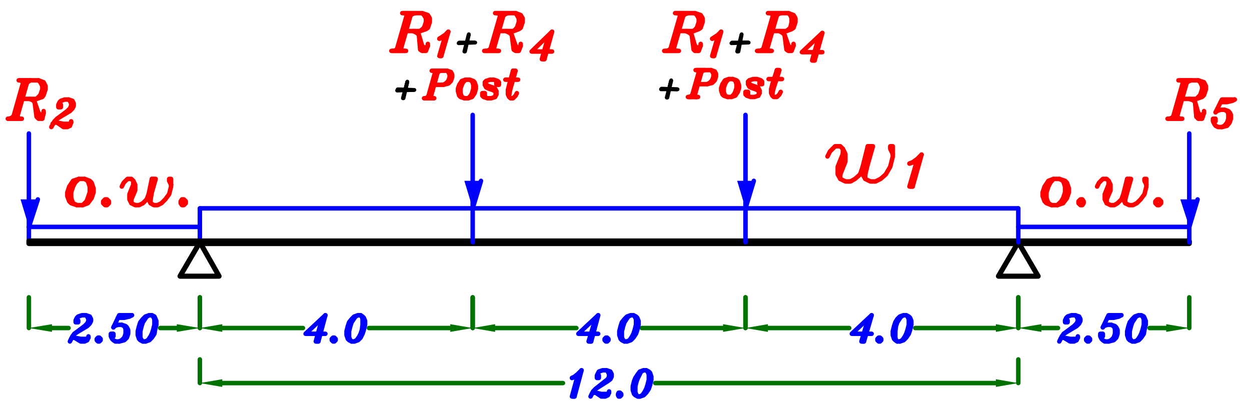
$$\boxed{\text{Weight of the Post} = 2.81 \ kN}$$

Note : Weight of Post can be neglected.

Loads on the Girder.

ملحوظه هامه . البلاطه مائله لكن الـ Girder أفقى





$$\frac{\sum area}{span} = \frac{4\left(\frac{1}{2}(4.17)\left(\frac{4.17}{2}\right)\right)}{12.0} = 1.45$$

$$g_1 = g_a = g_e = o.w. + \frac{\sum area}{span} * g_s$$

$$= 6.0 + 1.45\,(4.50) = 12.52 \; kN\backslash m$$

$$p_1 = p_a = p_e = \frac{\sum area}{span} * p_{si1}$$

$$= 1.45\,(0.957) = 1.387 \; kN\backslash m'$$

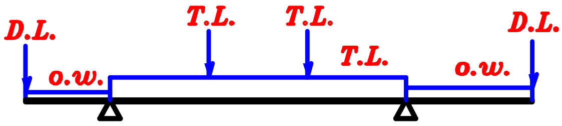
$$w_1 = w_a = w_e = g_1 + p_1 = 12.52 + 1.387 = 13.91 \; kN\backslash m'$$

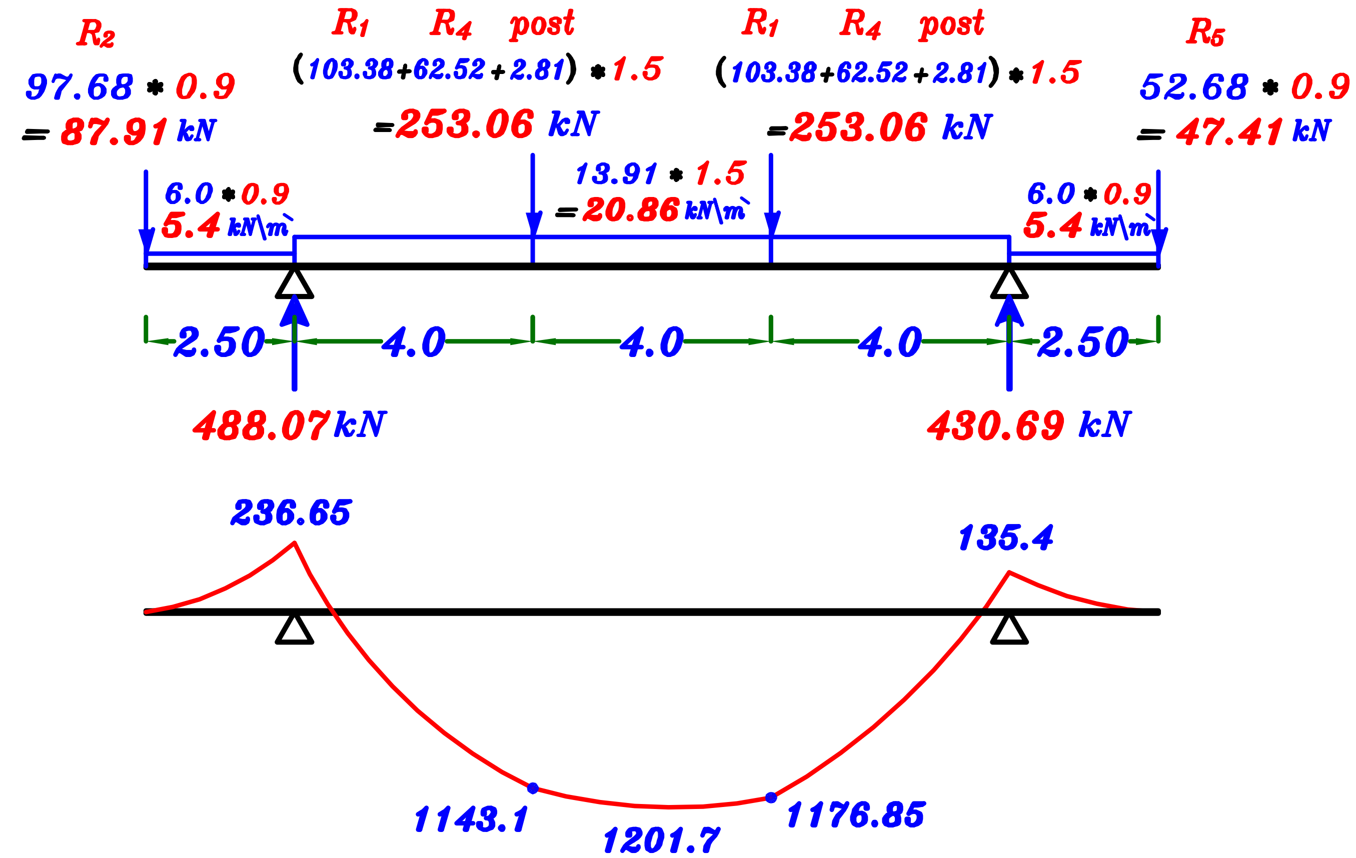
$$g_1 = 12.52 \; kN\backslash m' \text{ ---- D.L.}$$

$$w_1 = 13.91 \; kN\backslash m' \text{ ---- T.L.}$$

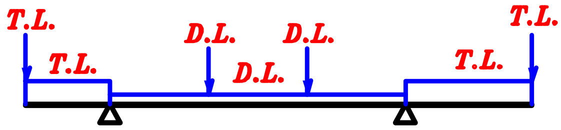
max-max U.L. B.M.D. For the Girder.

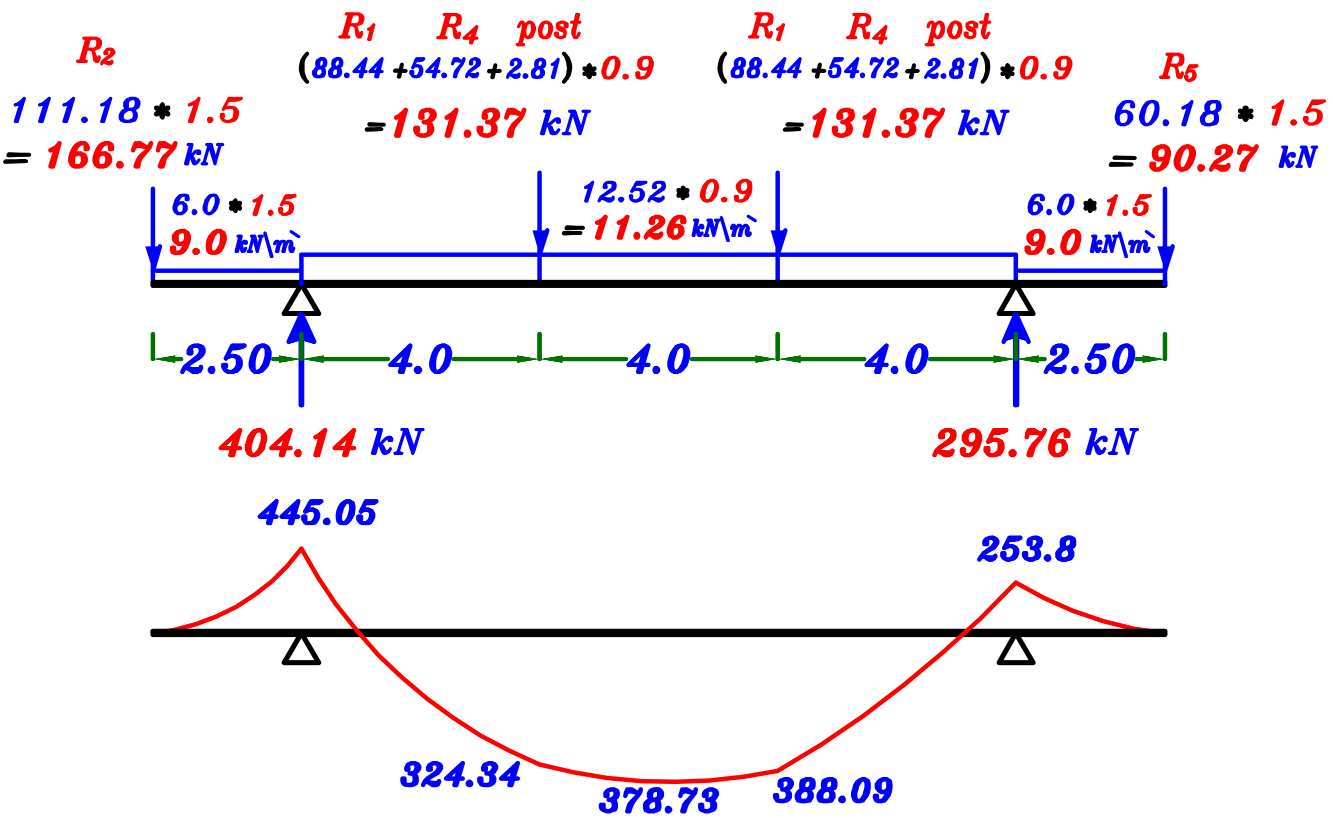
1- max. +ve B.M.D.



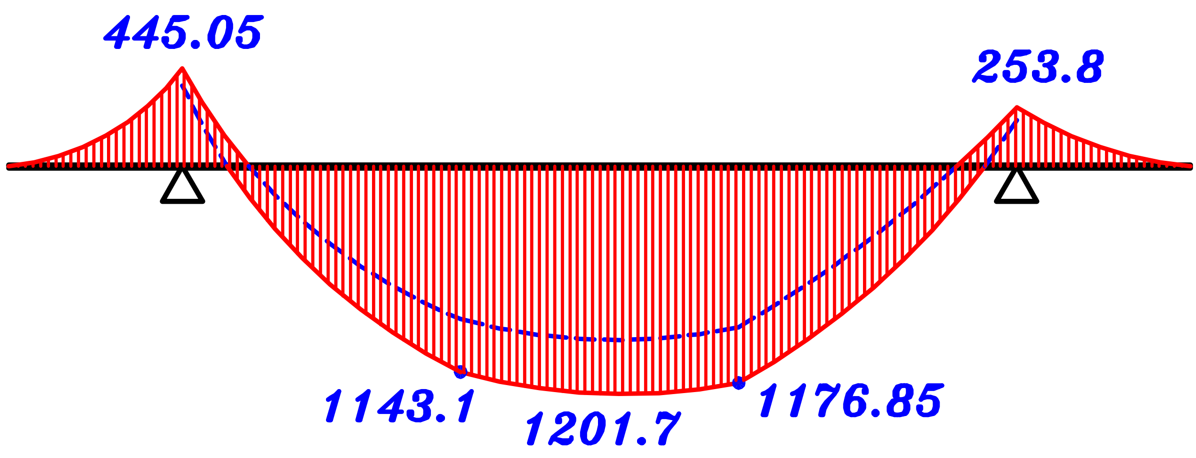


2- max. -ve B.M.D.

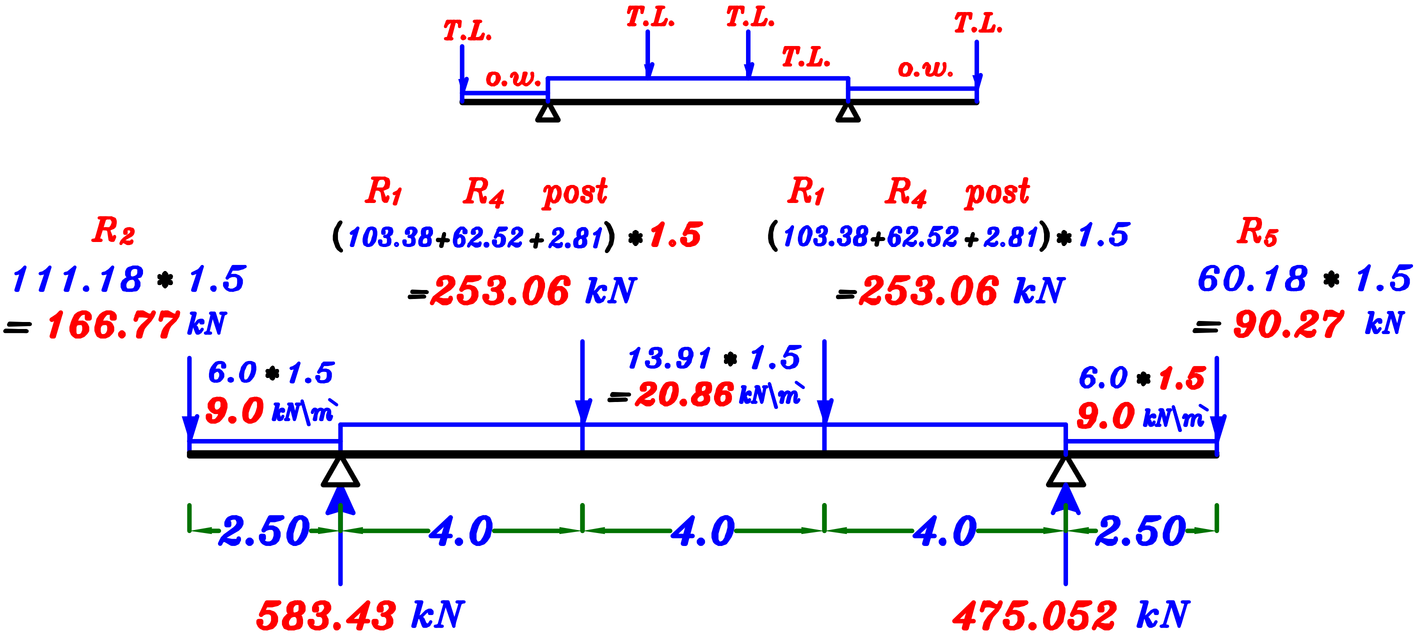


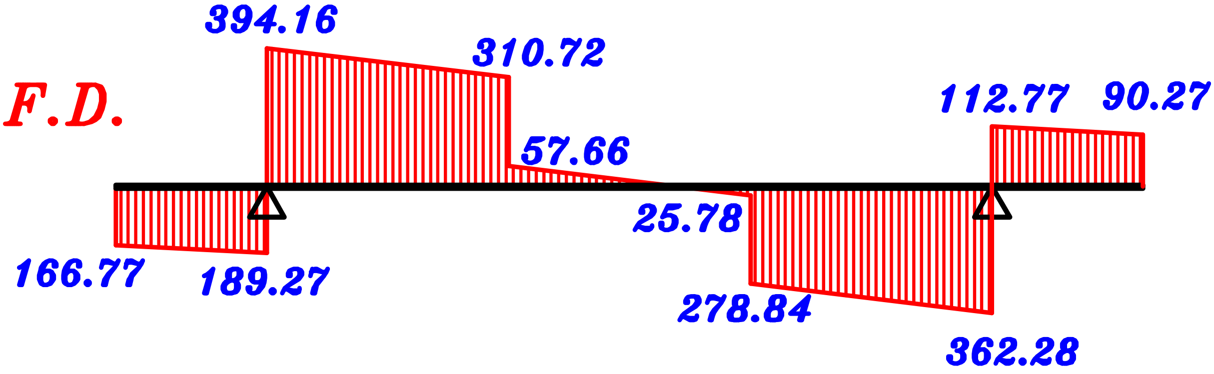


max–max B.M.D. For the Girder.

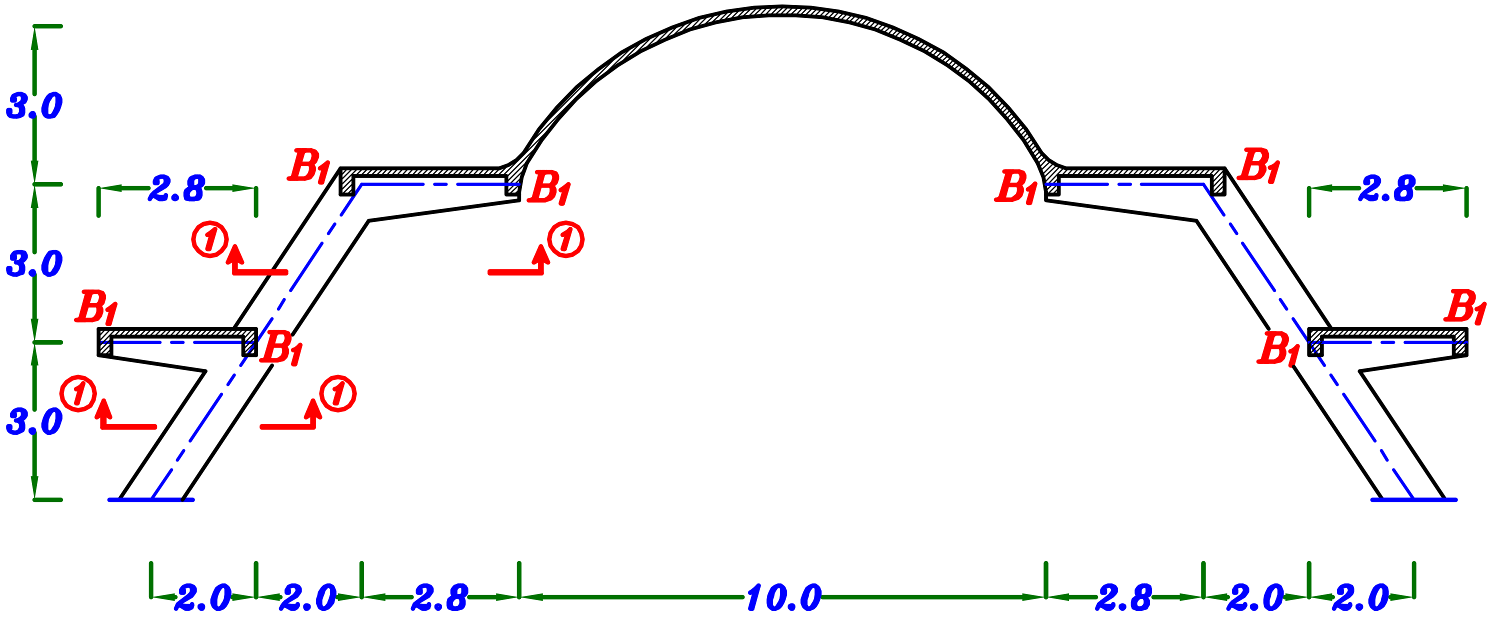


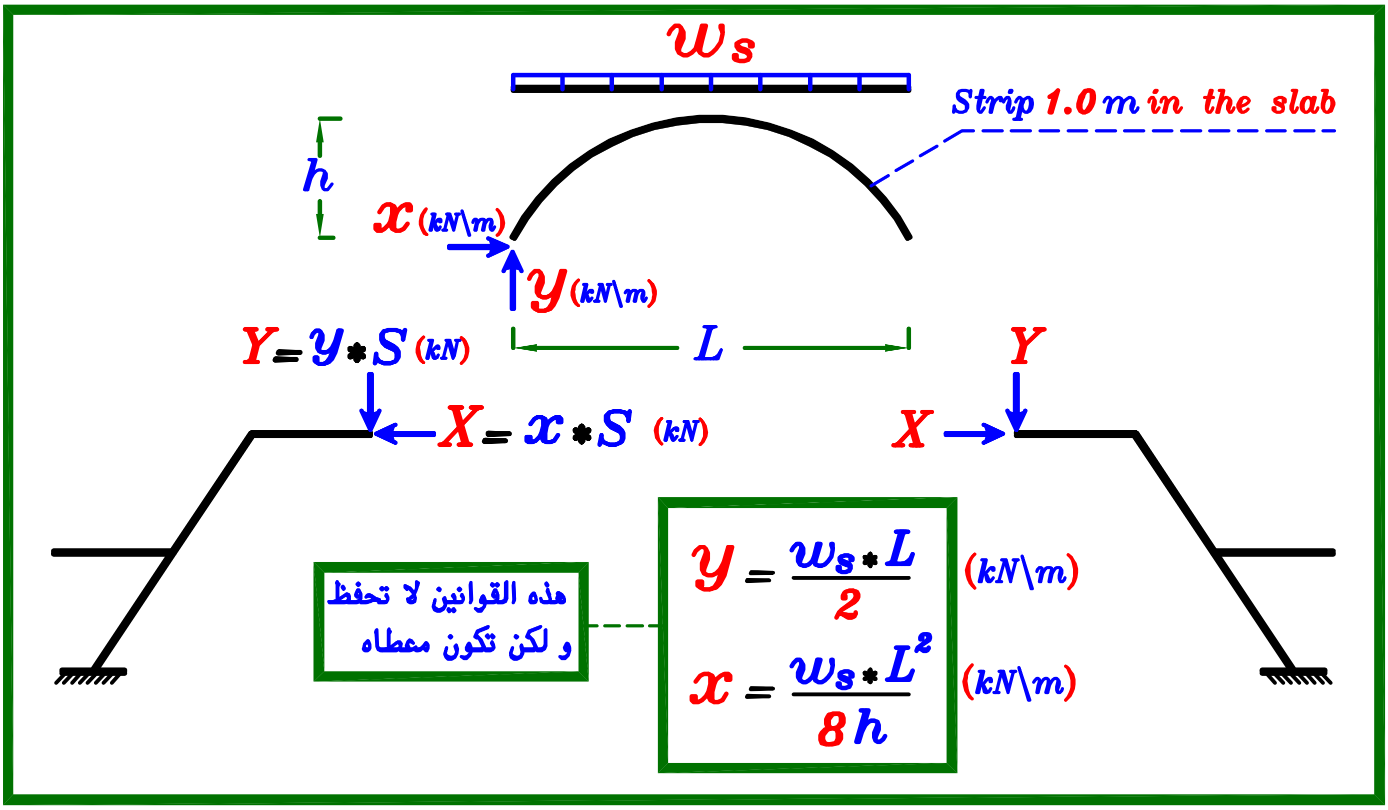
S.F.D. For the Girder.





Example.





Data.

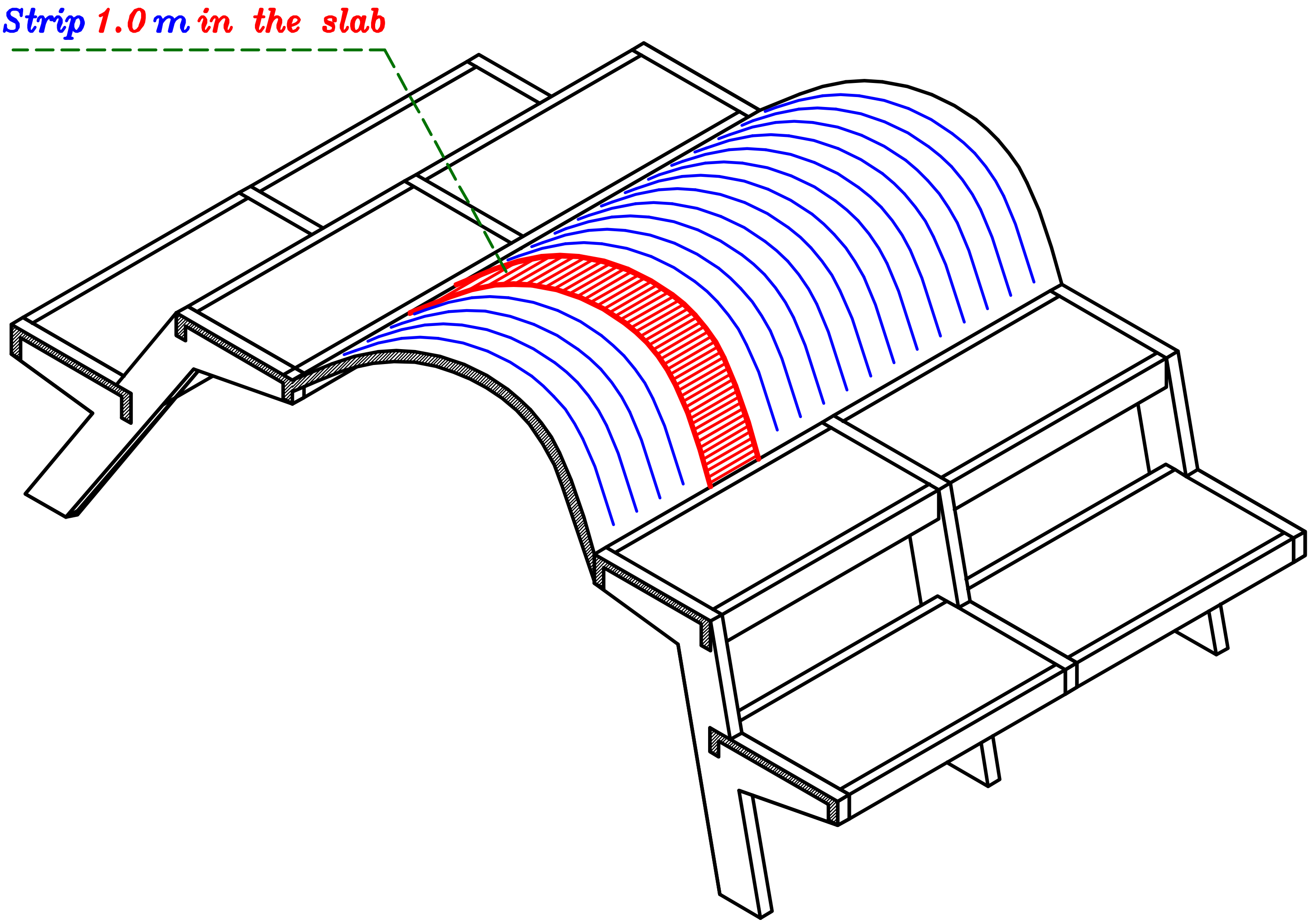
$t_s = 0.12$ m , F.C. = 1.50 N\mm^2 , L.L. = 2.0 N\mm^2

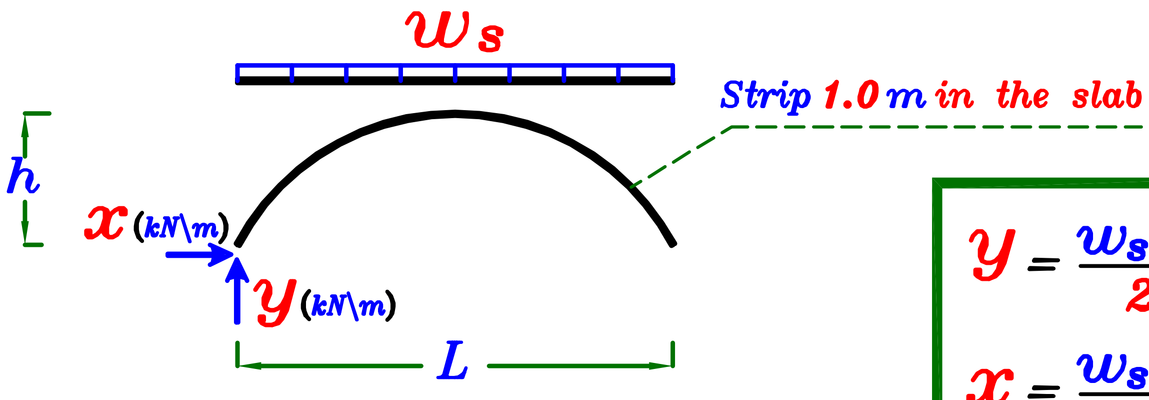
Spacing = 6.0 m , o.w.$_{(Frame)}$ = 6.0 kN\m` , o.w.$_{(Beams)}$ = 3.0 kN\m`

Req.

Draw Internal Forces Diagrams For the Frame.

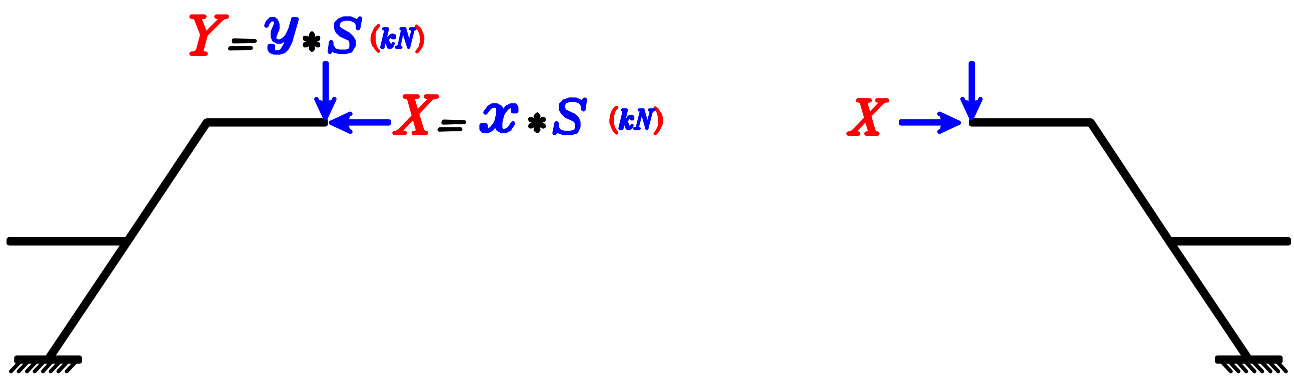
(Case of total Load only)





$$y = \frac{w_s * L}{2} \quad (kN\backslash m)$$

$$x = \frac{w_s * L^2}{8\,h} \quad (kN\backslash m)$$



$$w_s = t_s * \gamma_c + F.C. + L.L.$$

$$= 0.12 * 25 + 1.50 + 2.0 = 6.50 \ kN\backslash m^2$$

$$\boxed{w_s = 6.50 \ kN\backslash m^2}$$

$$L = 10 \ m \quad , \quad h = 3.0 \ m$$

هذه القوانين لا تحفظ
و لكن تكون معطاه

$$y = \frac{w_s * L}{2} = \frac{6.50 * 10}{2} = 32.5 \ kN\backslash m$$

$$Y = y * S = 32.5 * 6.0 = 195 \ kN \qquad \boxed{Y = 195 \ kN}$$

$$x = \frac{w_s * L^2}{8h} = \frac{6.50 * 10^2}{8 * 3.0} = 27.08 \ kN\backslash m$$

$$X = x * S = 27.08 * 6.0 = 162.5 \ kN \qquad \boxed{X = 162.5 \ kN}$$

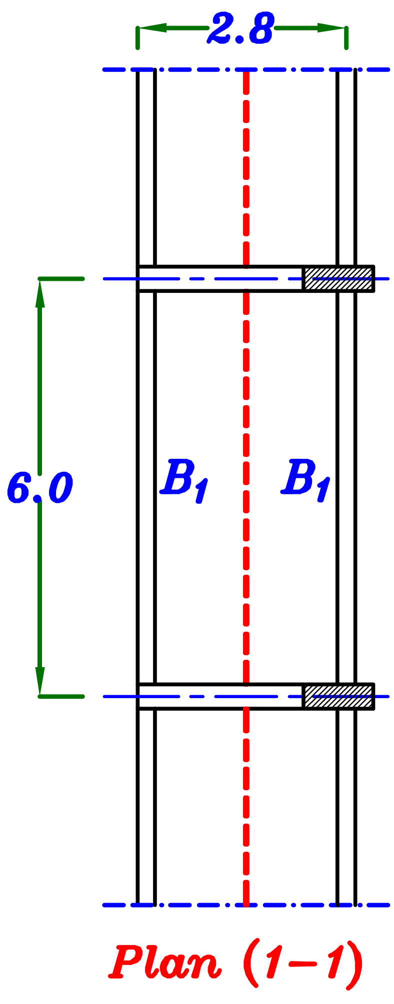
B_1

$$w_a = w_e = O.W. + \boxed{} \, w_s \frac{L_s}{2}$$

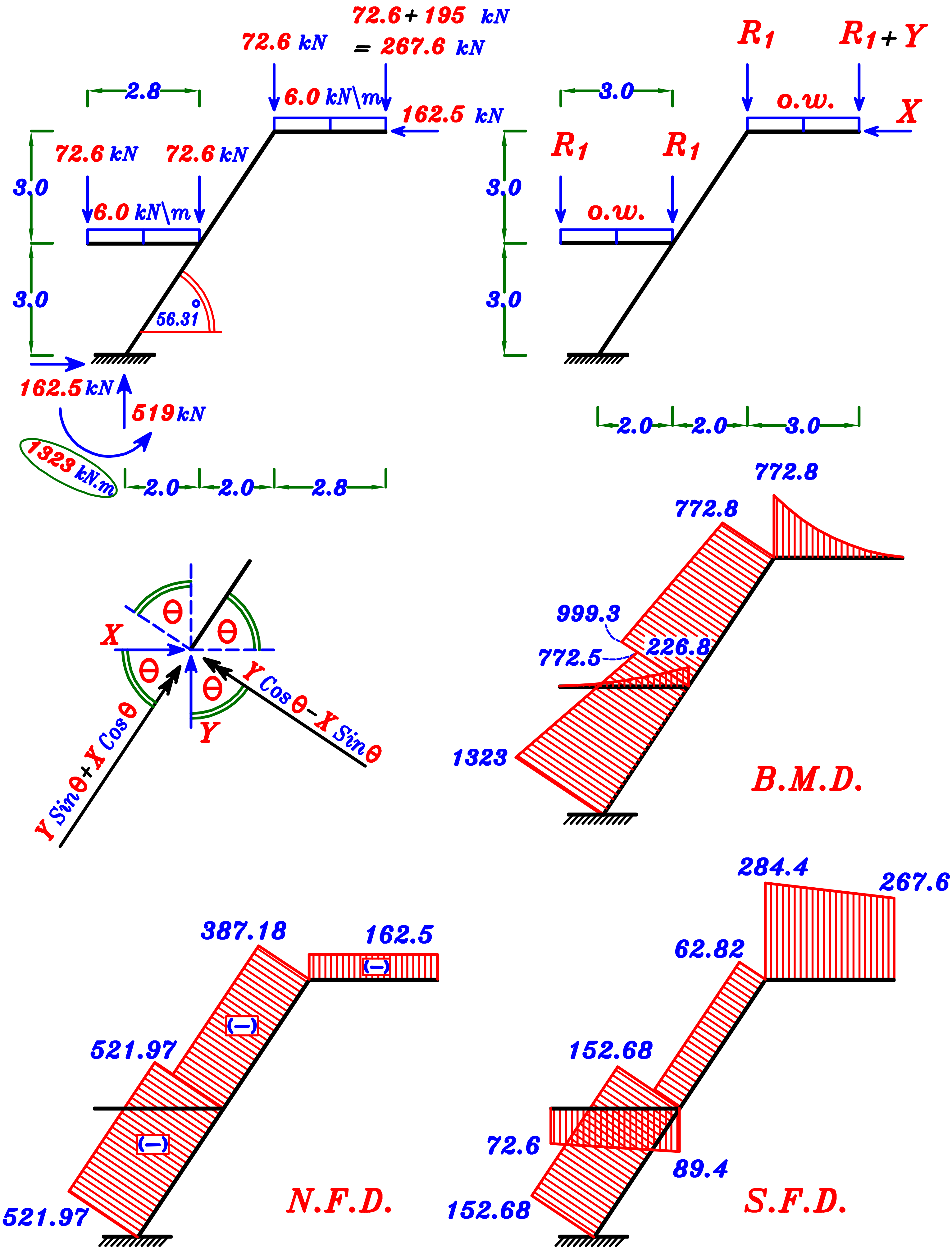
$$= 3.0 + (6.50)\left(\frac{2.8}{2}\right) = 12.1 \quad kN\backslash m'$$

$$R_1 = 12.10 * 6.0 = 72.6 \ kN$$

$$\boxed{R_1 = 72.6 \ kN}$$



Plan (1-1)


72.6 + 195 kN
= 267.6 kN
72.6 kN
2.8
6.0 kN\m
162.5 kN
72.6 kN
72.6 kN
3.0
6.0 kN\m
3.0
56.31°
162.5 kN
519 kN
1323 kN.m
2.0
2.0
2.8
R1
R1 + Y
3.0
o.w.
X
R1
R1
3.0
o.w.
3.0
2.0
2.0
3.0
X
θ
θ
θ
θ
Y
Y Cos θ - X Sin θ
Y Sin θ + X Cos θ
772.8
772.8
999.3
226.8
772.5
1323
B.M.D.
387.18
162.5
(−)
(−)
521.97
(−)
521.97
N.F.D.
284.4
267.6
62.82
152.68
72.6
89.4
152.68
S.F.D.

Example.

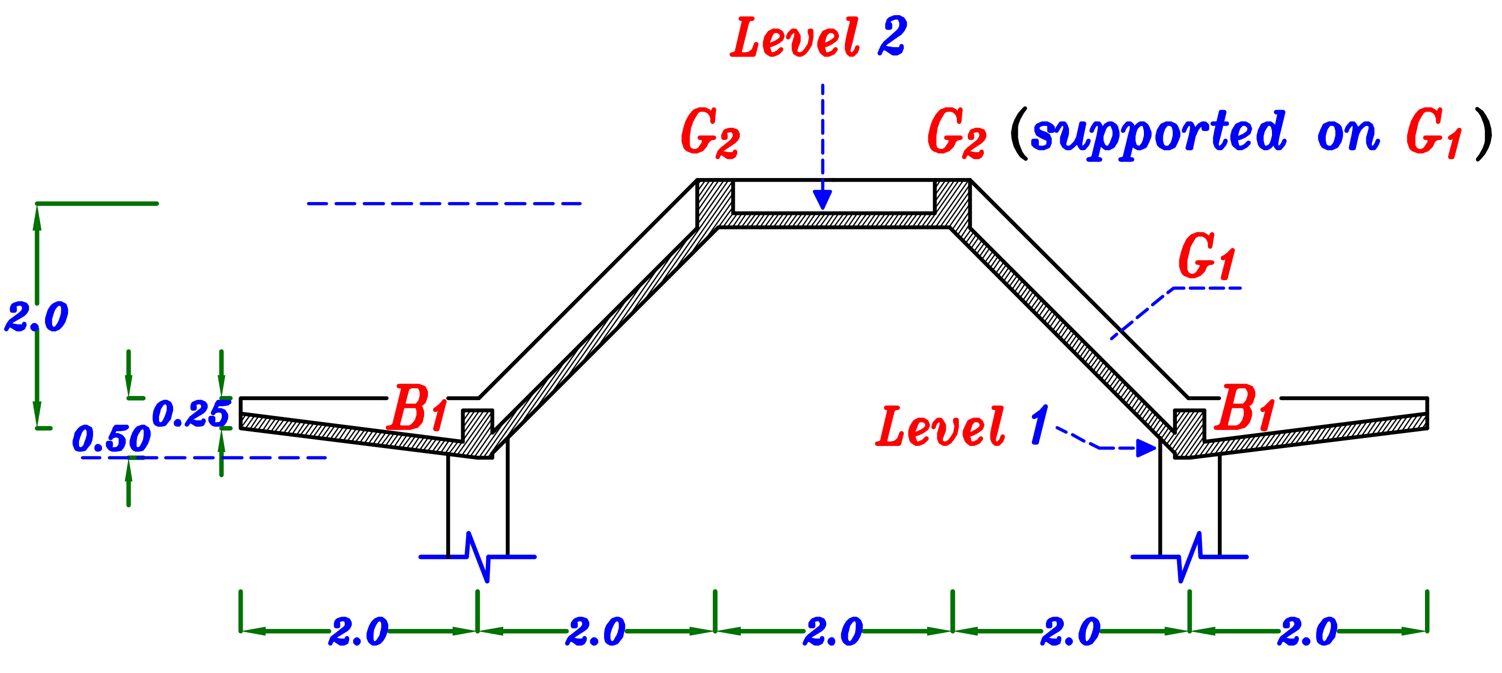
Figure 1 shows a sectional elevation and plan of a reinforced concrete shed. The shed covered by reinforced concrete slabs supported by a system of secondary beams (B_1) and Girders (G_1 & G_2) It is required to :

1- Draw a structural plan showing the pattern of load distribution.

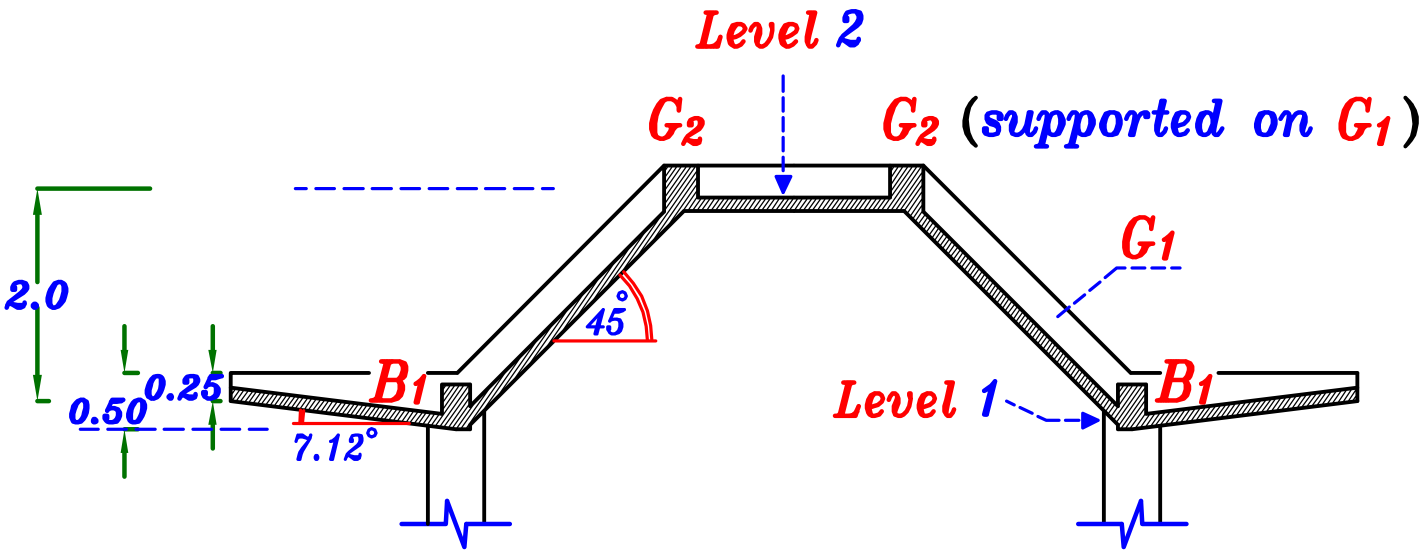
2- Calculate the equivalent working loads for shear and moment For secondary Beams (B_1) and Girders (G_1 & G_2) .

3- Draw the N.F.D. (Total Loads) , S.F.D. (Total Loads) and (max-max B.M.D.) For Girder (G_1) only, Using ultimate limit loads.

Data:
- Slab thickness $t_s = 140$ mm
- Live load = 1.5 kN\m² HL. projection.
- Floor cover = 1.0 kN\m²
- Own weight of beams = 3.0 kN\m
- Own weight of girders = 6.0 kN\m



Cross-Section (X-X)



Cross-Section (X-X)

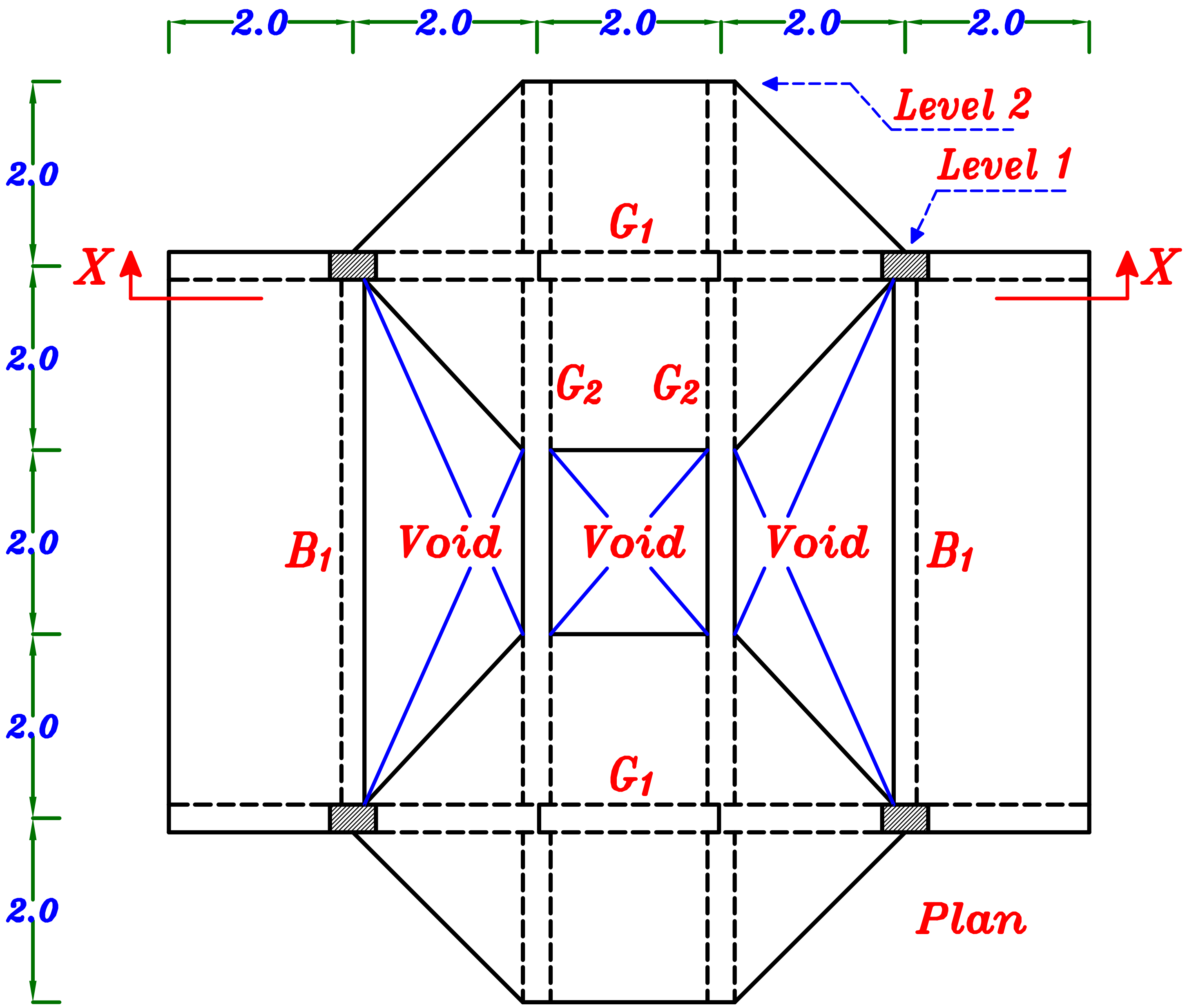
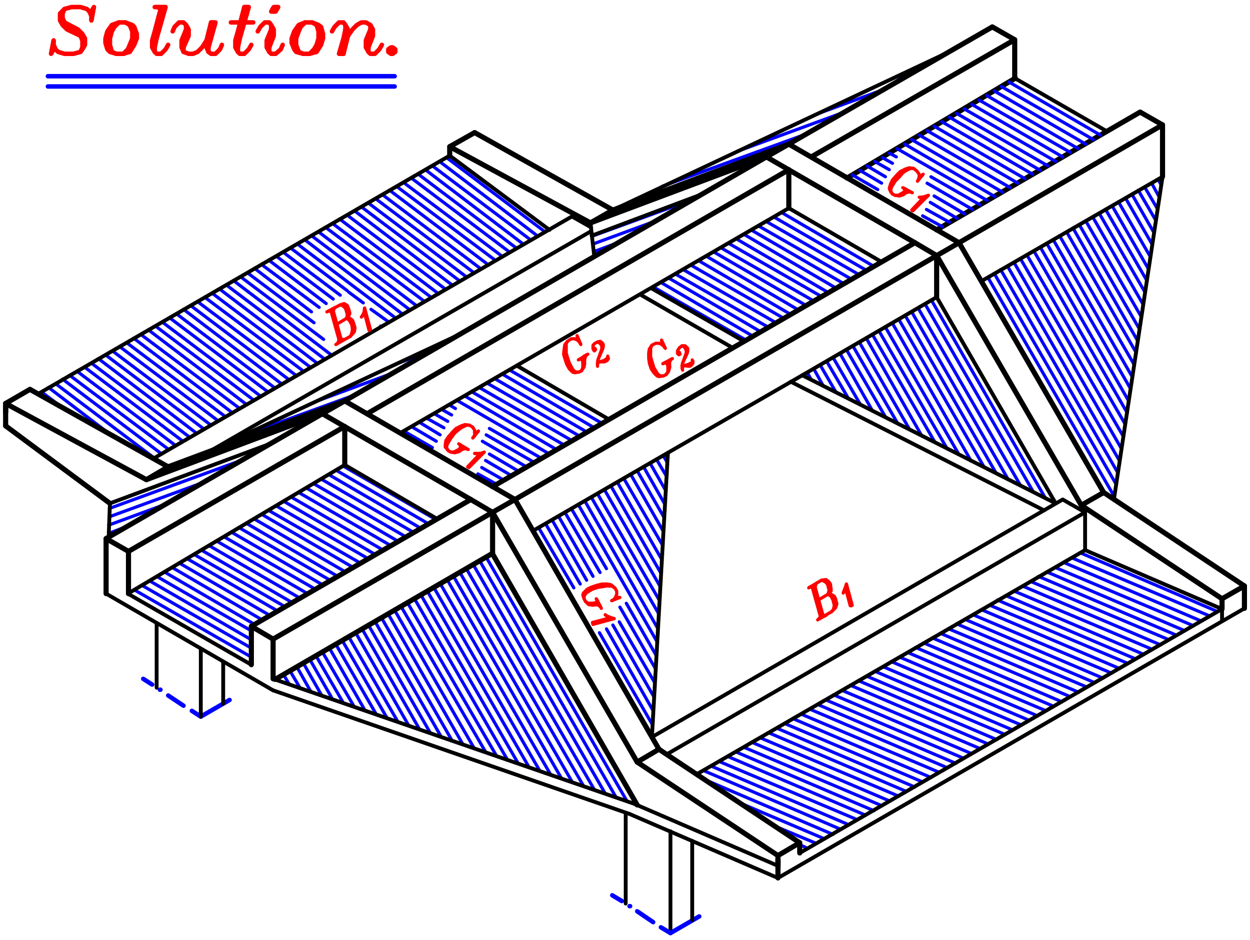
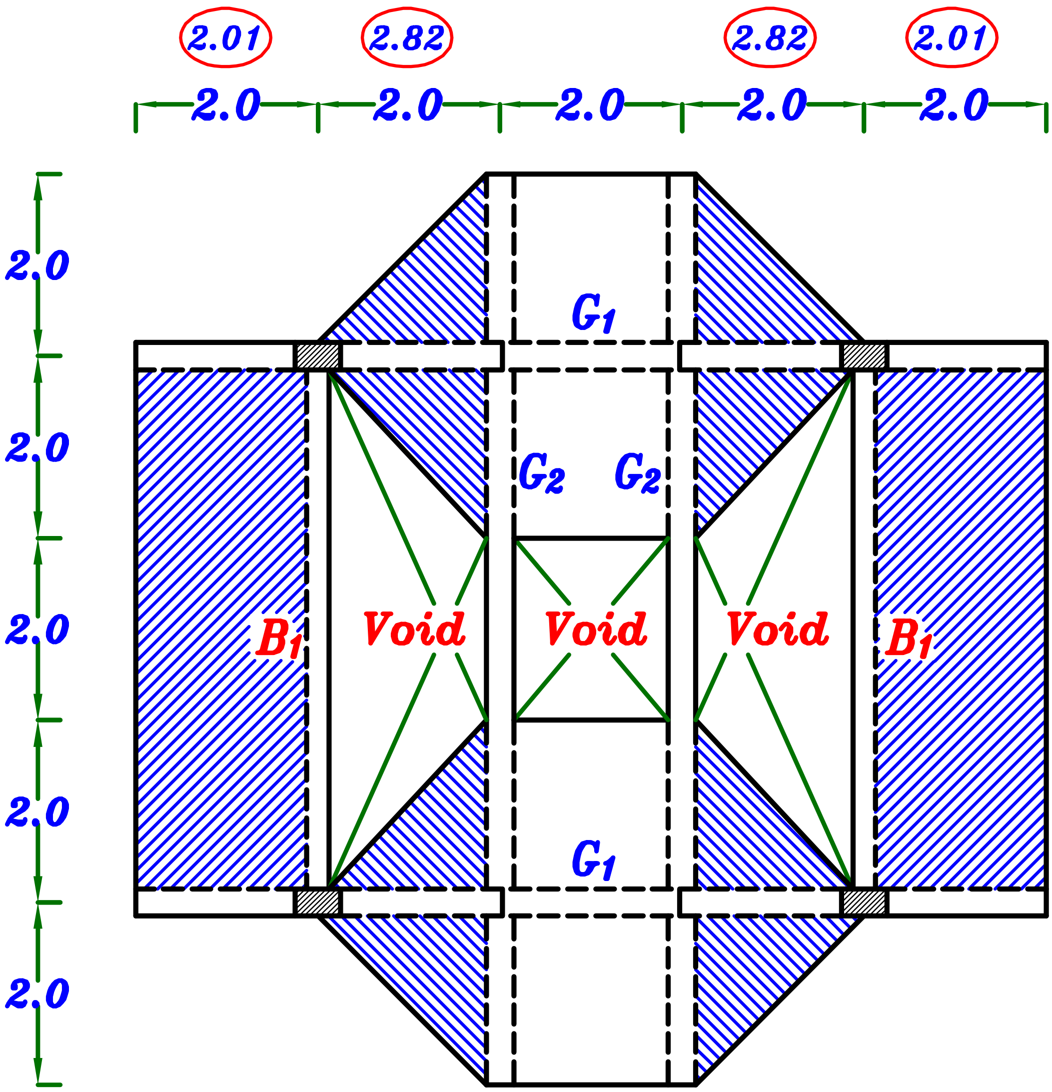


Figure 1

Solution.



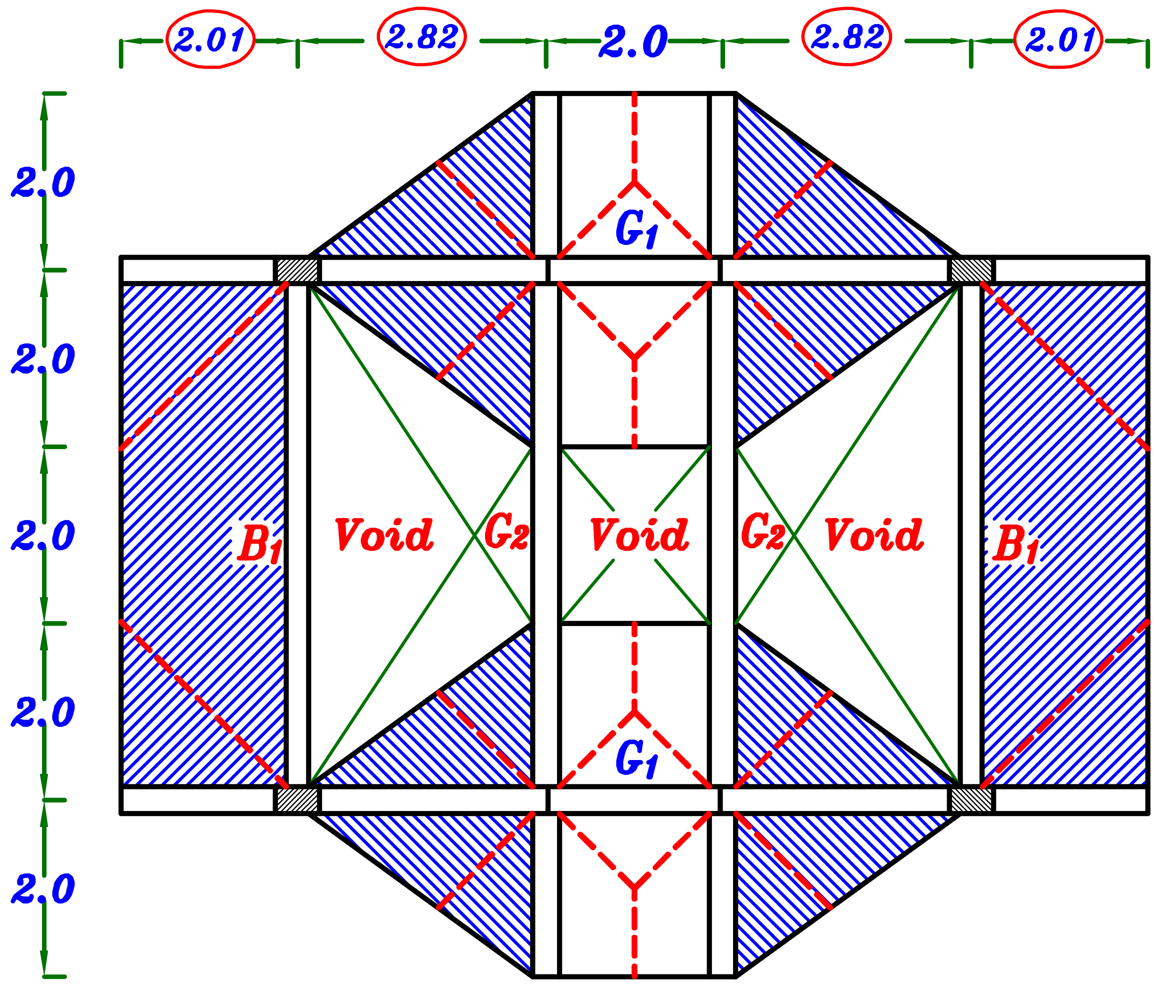
B1
G2
G2
G1
G1
G1
B1



2.01
2.82
2.82
2.01
2.0
2.0
2.0
2.0
2.0
2.0
2.0
2.0
2.0
2.0
G1
G2
G2
B1
Void
Void
Void
B1
G1

1 – Draw a structural plan showing the pattern of load distribution.

أرسم ال **plan** بالاطوال الحقيقيه بمقياس رسم مناسب لقياس بعض الاطوال منه .



g_s , p_s

$g_s = t_s * \gamma_c + F.C. = 0.14 * 25 + 1.0 = 4.5 \ kN\backslash m^2$

$p_{sh} = L.L. = 1.5 \ kN\backslash m^2$ ----- HL. Slab.

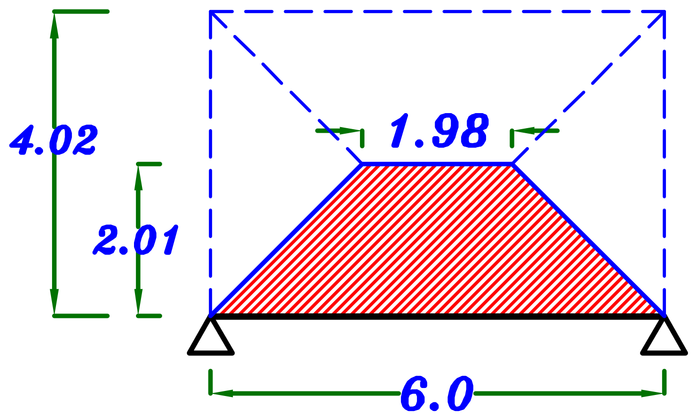
$p_{si1} = L.L. * Cos\,\theta = 1.5 * Cos\ 45^\circ = 1.06 \ kN\backslash m^2$ --- For Inclination 45°

$p_{si2} = L.L. * Cos\,\theta = 1.5 * Cos\ 7.12^\circ = 1.49 \ kN\backslash m^2$ --- For Inclination 7.12°

$\boxed{g_s = 4.5 \ kN\backslash m^2}$, $\boxed{p_{sh} = 1.5 \ kN\backslash m^2}$

$\boxed{p_{si1} = 1.06 \ kN\backslash m^2}$, $\boxed{p_{si2} = 1.49 \ kN\backslash m^2}$

B_1

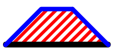


For Trapezoid

$$C_a = 1 - \frac{1}{2}\left(\frac{L_s}{L}\right) = 1 - \frac{1}{2}\left(\frac{4.02}{6}\right) = 0.665$$

$$C_e = 1 - \frac{1}{3}\left(\frac{L_s}{L}\right)^2 = 1 - \frac{1}{3}\left(\frac{4.02}{6}\right)^2 = 0.85$$

Load For Shear.



$$g_a = o.w. + C_a \, g_s \, L_c = 3.0 + (0.665)(4.50)(2.01) = 9.01 \; kN\backslash m'$$

$$p_a = C_a \, p_{si2} \, L_c = (0.665)(1.49)(2.01) = 1.99 \; kN\backslash m'$$

$$w_a = g_a + p_a = 9.01 + 1.99 = 11.0 \; kN\backslash m'$$

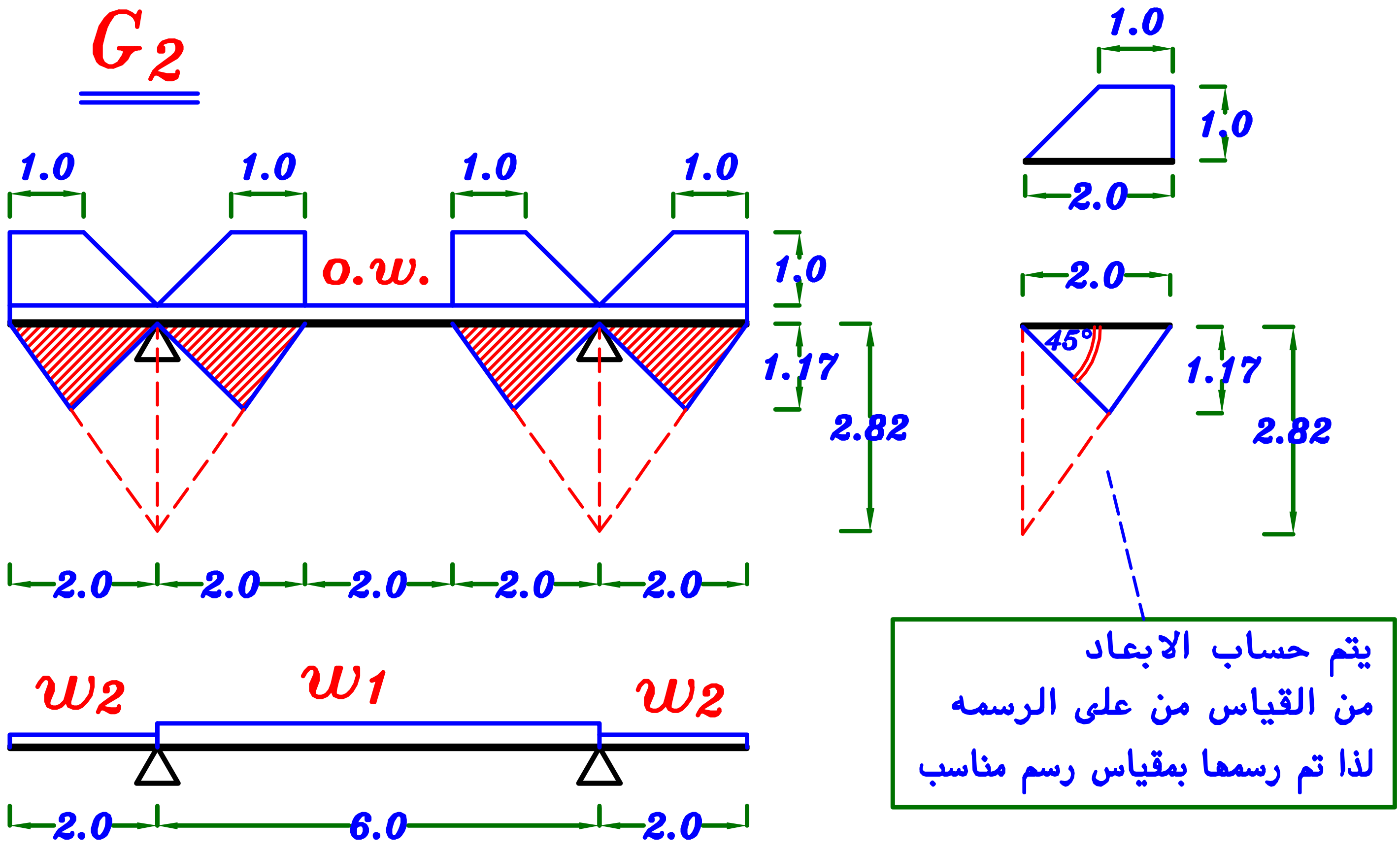
Load For Moment.

$$g_e = o.w. + C_e \, g_s \, L_c = 3.0 + (0.85)(4.50)(2.01) = 10.69 \; kN\backslash m'$$

$$p_e = C_e \, p_{si2} \, L_c = (0.85)(1.49)(2.01) = 2.54 \; kN\backslash m'$$

$$w_e = g_e + p_e = 10.69 + 2.54 = 13.23 \; kN\backslash m'$$

G_2



w_1

$$\frac{\sum area}{span}\,1 = \frac{2\left(\frac{2+1}{2}\right)(1.0)}{6.0} = 0.50$$

$$\frac{\sum area}{span}\,2 = \frac{2\left(\frac{1}{2}*2*1.17\right)}{6.0} = 0.39$$

Load For Shear = Load For Moment.

$$g_{1a} = g_{1e} = O.W. + \frac{\sum area}{span}\,1 * g_s + \frac{\sum area}{span}\,2 * g_s$$

$$= 6.0 + (0.50)(4.5) + (0.39)(4.5) = 10.0 \quad kN \backslash m`$$

$$p_{1a} = p_{1e} = \frac{\sum area}{span}\,1 * p_{sh} + \frac{\sum area}{span}\,2 * p_{si1}$$

$$= (0.50)(1.5) + (0.39)(1.06) = 1.163 \quad kN \backslash m`$$

$$w_{1a} = w_{1e} = g_1 + p_1 = 10.0 + 1.163 = 11.163 \quad kN \backslash m`$$

w_2

$$\frac{\sum \text{area}}{\text{span}}\ 1 = \frac{\left(\frac{2+1}{2}\right)(1.0)}{2.0} = 0.75$$

$$\frac{\sum \text{area}}{\text{span}}\ 2 = \frac{\left(\frac{1}{2} * 2 * 1.17\right)}{2.0} = 0.585$$

Load For Shear = Load For Moment.

$$g_{2a} = g_{2e} = O.W. + \frac{\sum \text{area}}{\text{span}}\ 1 * g_s + \frac{\sum \text{area}}{\text{span}}\ 2 * g_s$$

$$= 6.0 + (0.75)(4.5) + (0.585)(4.5) = 12.0 \ kN\backslash m`$$

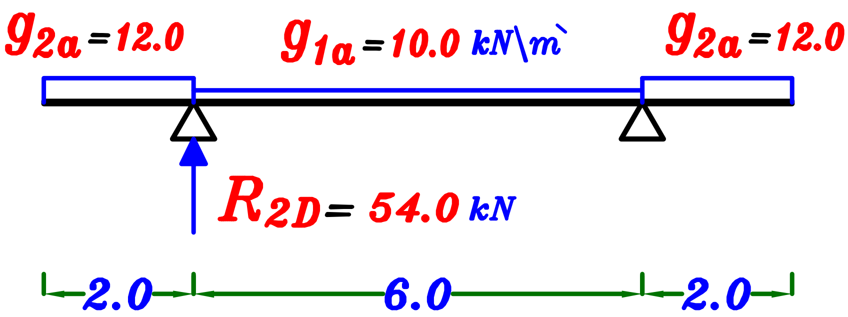
$$p_{2a} = p_{2e} = \frac{\sum \text{area}}{\text{span}}\ 1 * p_{sh} + \frac{\sum \text{area}}{\text{span}}\ 2 * p_{si1}$$

$$= (0.75)(1.5) + (0.585)(1.06) = 1.74 \ kN\backslash m`$$

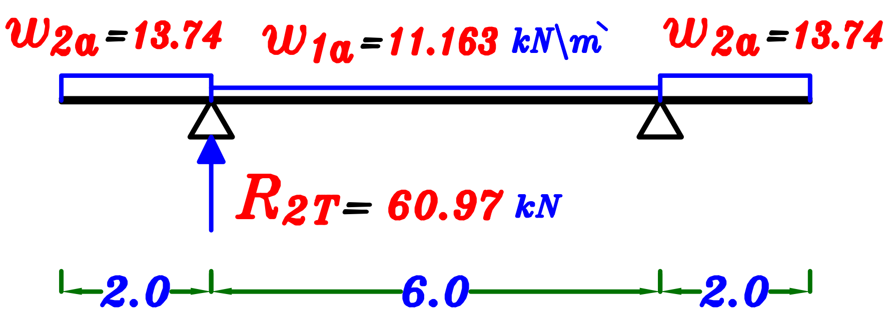
$$w_{2a} = w_{2e} = g_2 + p_2 = 12.0 + 1.74 = 13.74 \ kN\backslash m`$$

Reaction of gireder G_2

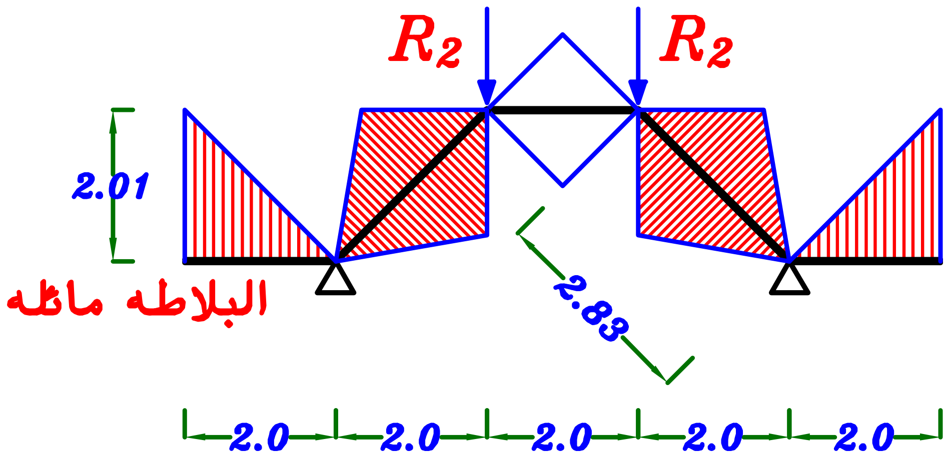
$$\boxed{R_{2D} = 54.0 \ kN}$$



$$\boxed{R_{2T} = 60.97 \ kN}$$

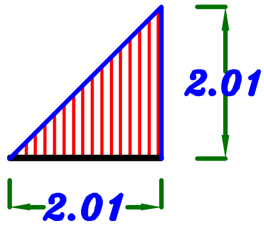


G_1

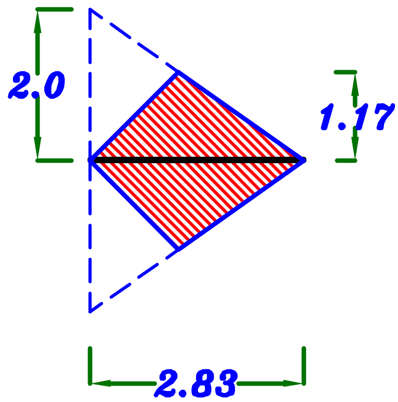


البلاطه مائله و لكن ال girder cantilever أفقى

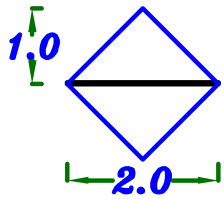
$$\frac{\sum area}{span} = \frac{\left(\frac{1}{2} * 2.01 * 2.01\right)}{2.0} = 1.01$$

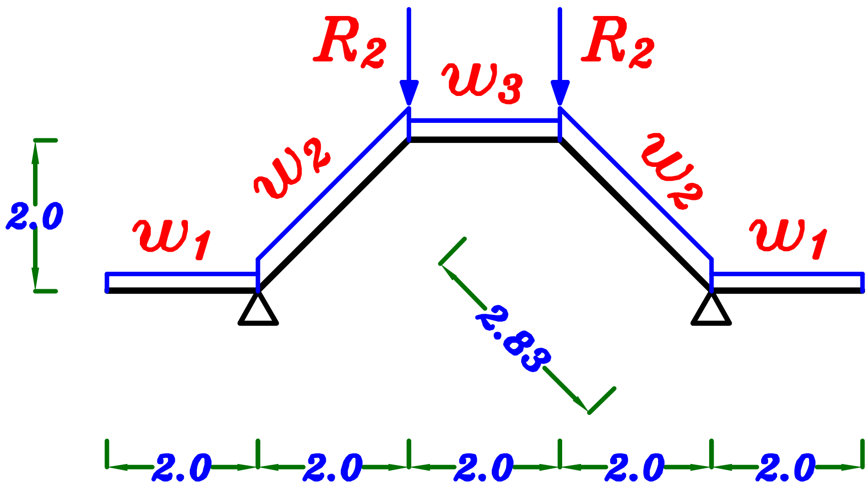


$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2} * 2.83 * 1.17\right)}{2.83} = 1.17$$



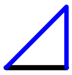
$$\frac{\sum area}{span} = \frac{2\left(\frac{1}{2} * 2 * 1.0\right)}{2.0} = 1.0$$





$W1$

Load For Shear = Load For Moment



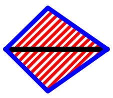
$$g_1 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.01)(4.5) = 10.545 \ kN \backslash m`$$

$$p_1 = \frac{\sum area}{span} * p_{si2} = (1.01)(1.49) = 1.505 \ kN \backslash m`$$

$$w_1 = g + p = 10.545 + 1.505 = 12.05 \ kN \backslash m`$$

$W2$

Load For Shear = Load For Moment



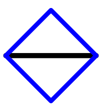
$$g_2 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.17)(4.5) = 11.265 \ kN \backslash m`$$

$$p_2 = \frac{\sum area}{span} * p_{si1} = (1.17)(1.06) = 1.24 \ kN \backslash m`$$

$$w_2 = g + p = 11.265 + 1.24 = 12.505 \ kN \backslash m`$$

$W3$

Load For Shear = Load For Moment



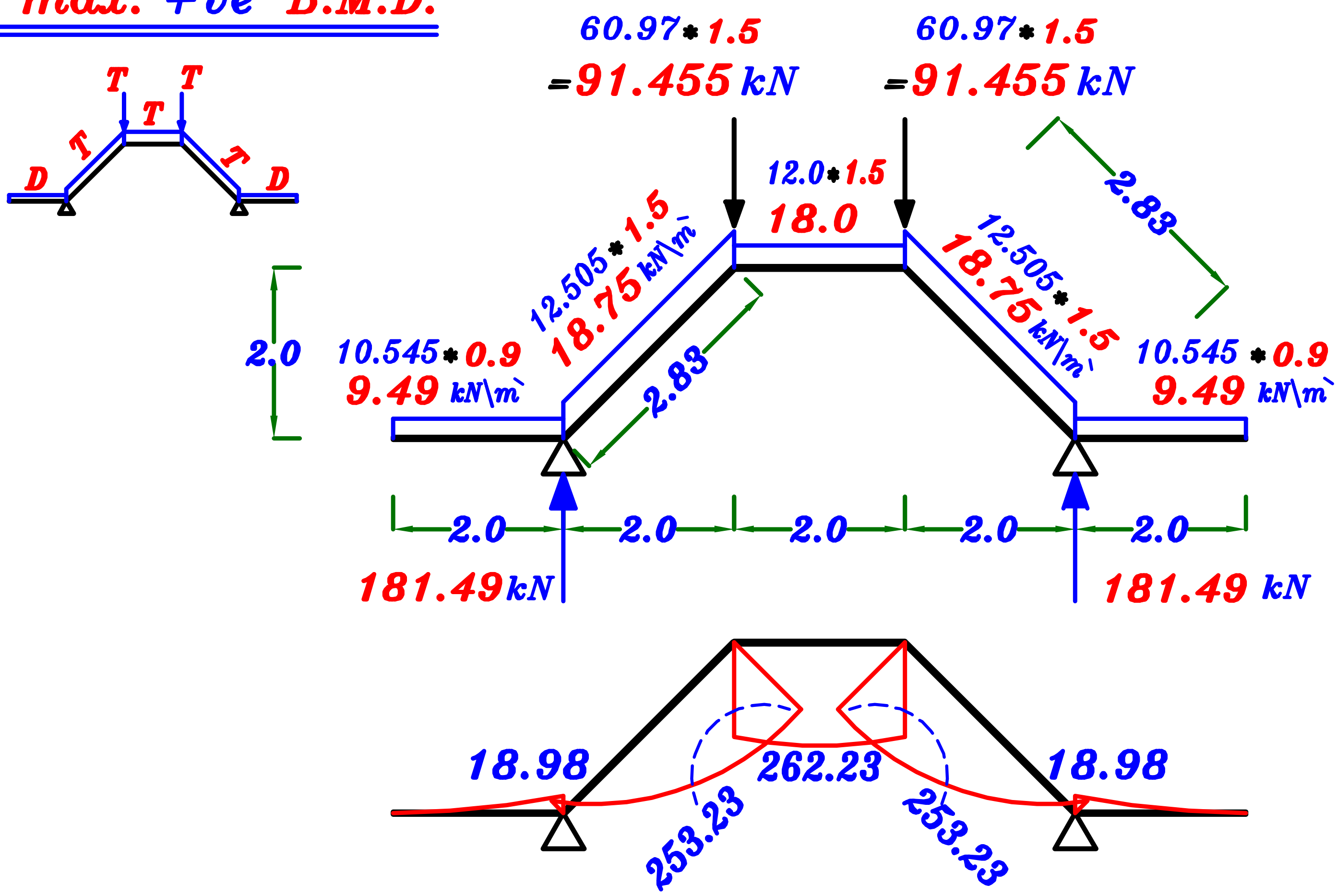
$$g_3 = O.W. + \frac{\sum area}{span} * g_s = 6.0 + (1.0)(4.5) = 10.5 \ kN \backslash m`$$

$$p_3 = \frac{\sum area}{span} * p_{sh} = (1.0)(1.5) = 1.50 \ kN \backslash m`$$

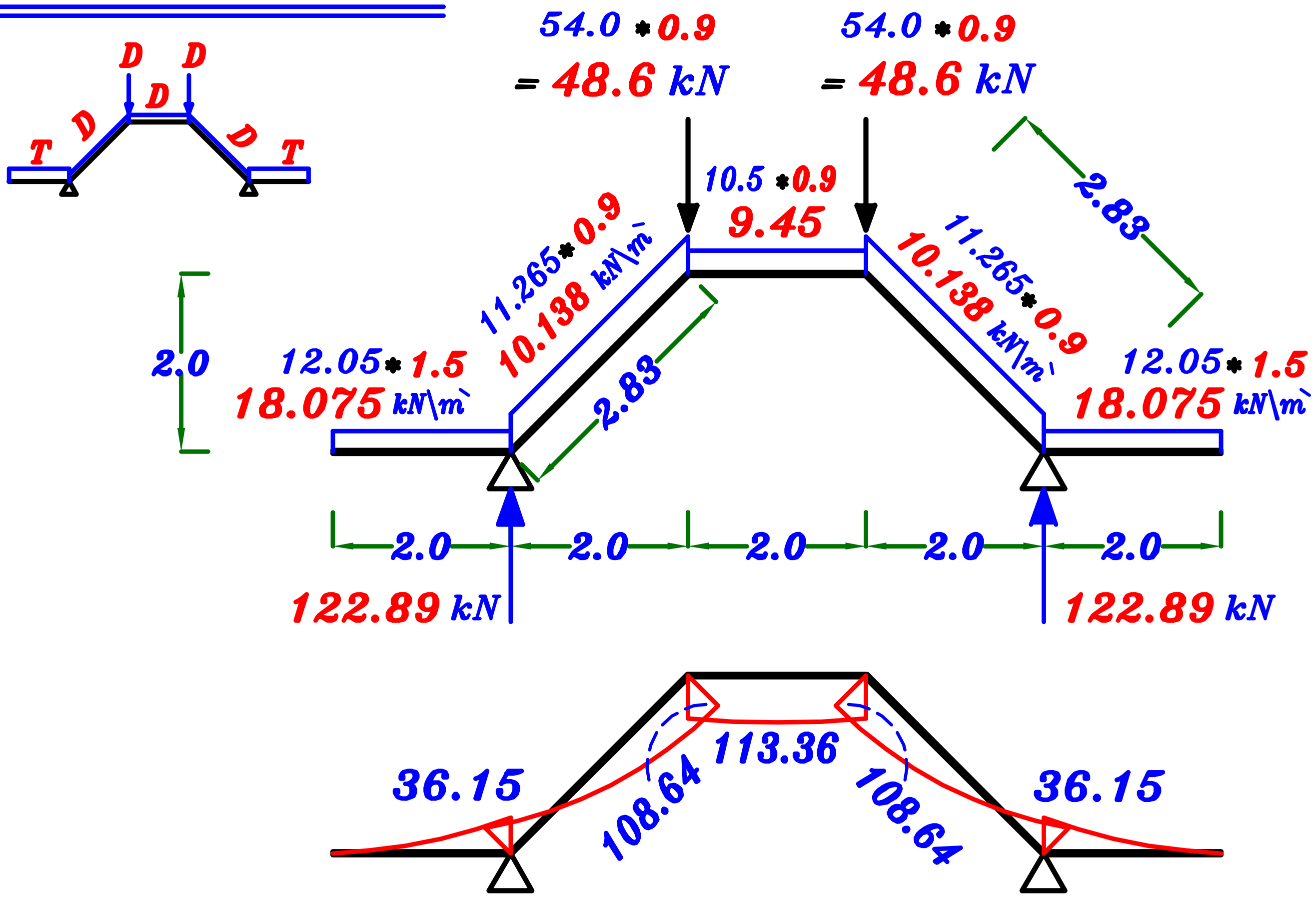
$$w_3 = g + p = 10.5 + 1.50 = 12.0 \ kN \backslash m`$$

max–max U.L. B.M.D. For the Girder. G_1

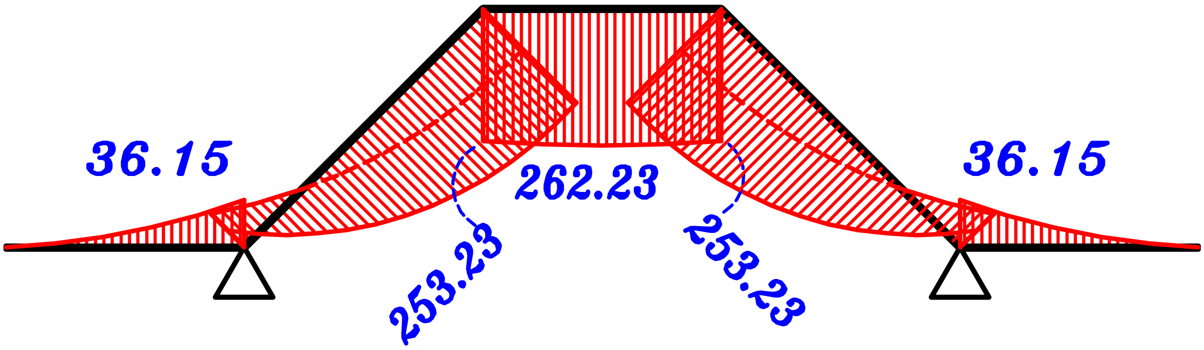
1- max. +ve B.M.D.



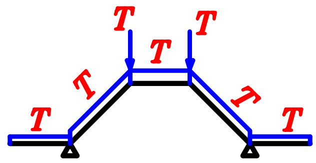
2- max. –ve B.M.D.

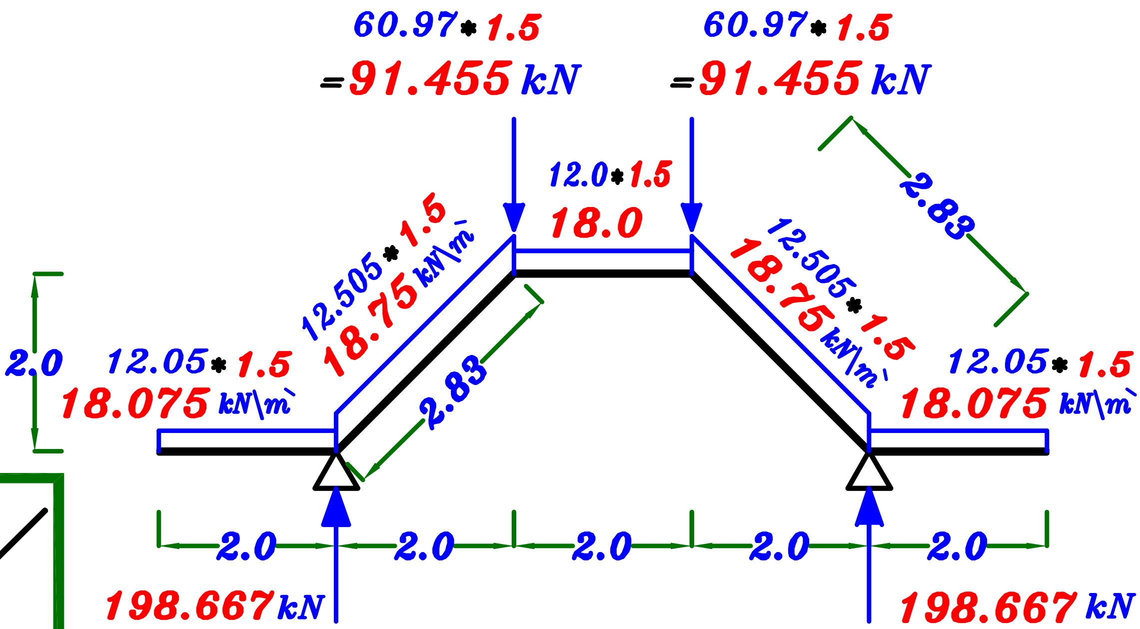


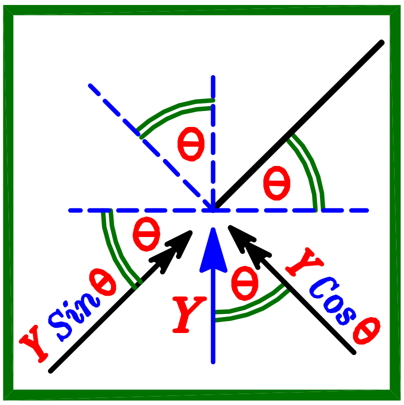
max–max U.L. B.M.D. For the Girder. G_1

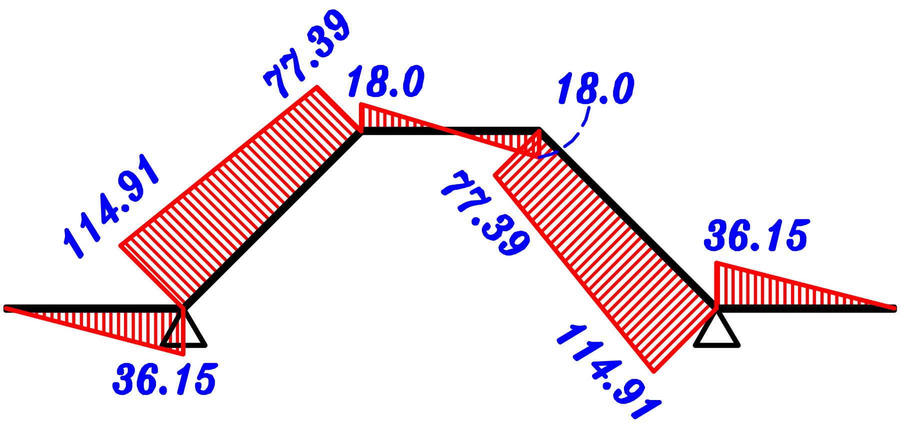


U.L. S.F.D. & N.F.D. For the Girder G_1

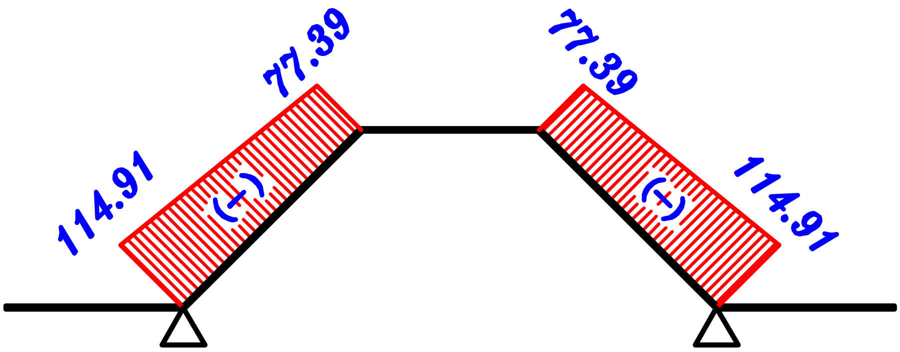








S.F.D.

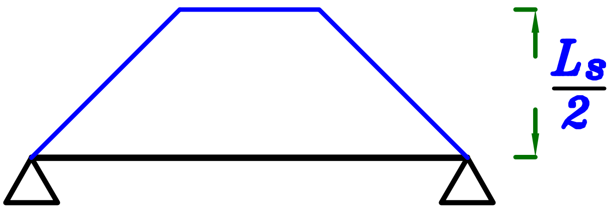


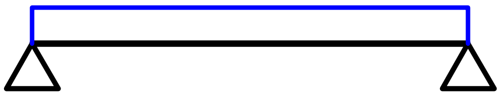
N.F.D.

اذا كان شكل الحمل من الاشكال المحفوظه لها C_a ، C_e سنستخدم طريقه C_a ، C_e

$C_a \, w_s \, \frac{L_s}{2}$ ---- For shear

$C_e \, w_s \, \frac{L_s}{2}$ ---- For moment

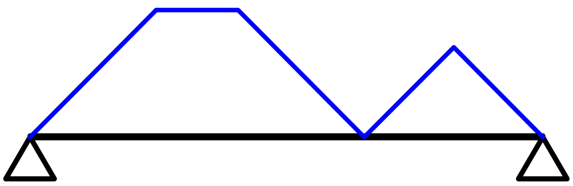




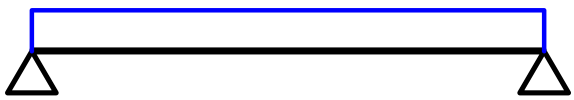
اذا كان شكل الحمل ليس من الاشكال المحفوظه لها C_a ، C_e

Approximate method.

عاده نستخدم لها طريقه تقريبيه و هى $\frac{\sum area}{span} * w_s$



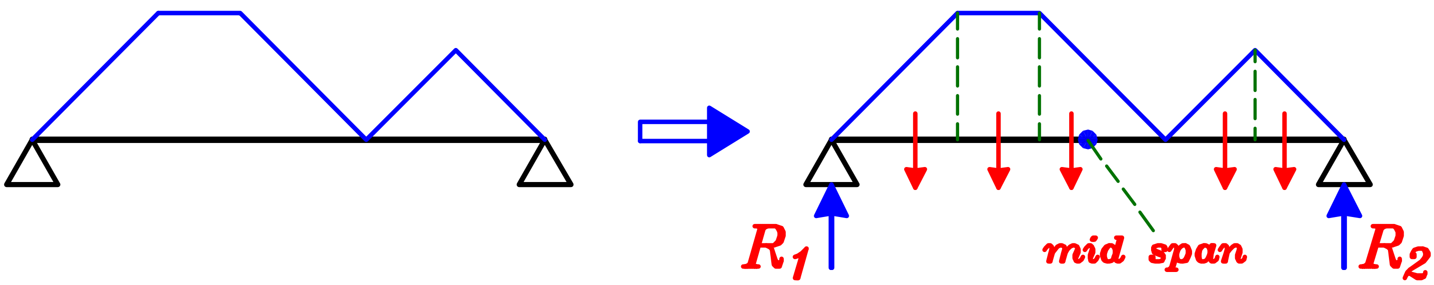
$\frac{\sum area}{span} * w_s$



Exact method.

اما اذا تم طلب استخدام الطريقه الـ **Exact** مع شكل حمل ليس محفوظ له C_a ، C_e

فيتم تقسيم كل شكل الى مساحات و حساب الاوزان و تحديد اماكنها فى $C.G.$ كل مساحه .



ثم يتم حساب الـ **Reactions** للكمره و يتم حساب اكبر **Shear** هو قيمه اكبر **Reaction**

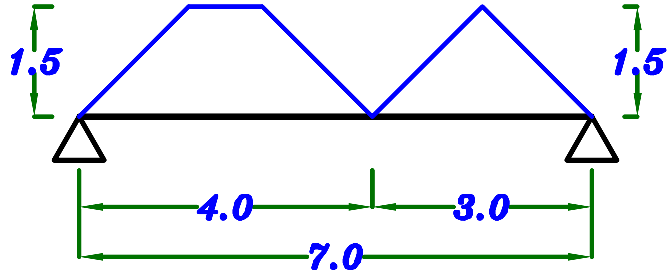
و لتحديد اكبر **bending moment** يجب تحديد مكان نقطه الـ **zero shear**

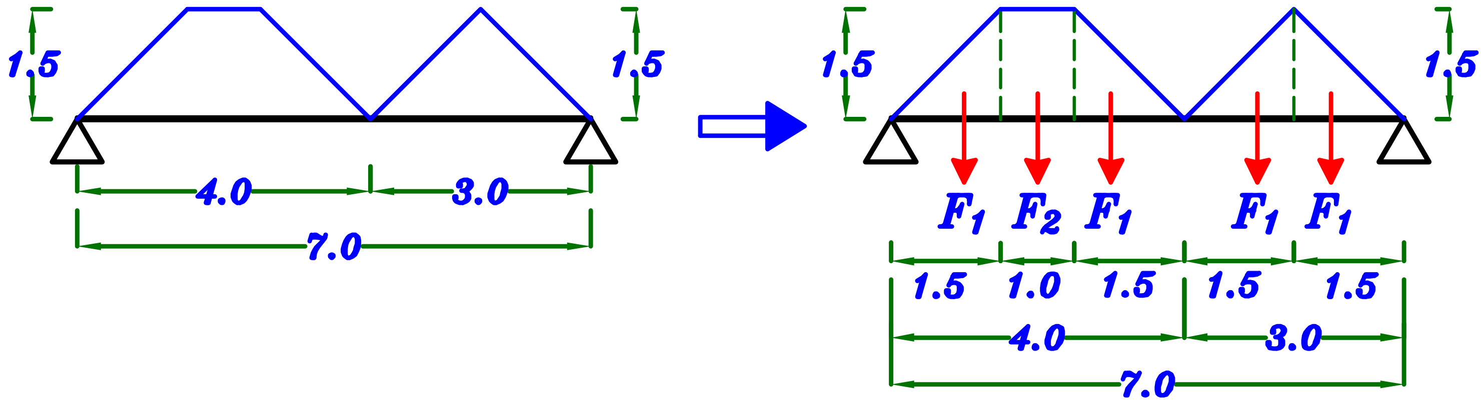
و هذا سيكون صعب جدا مع الاشكال الغير منتظمه **(سيحتاج الى تكامل)** لذا سنعتبر انها فى

منتصف الـ **span** للتسهيل و نحسب قيمه الـ **moment** فى منتصف الـ **span**

Example.

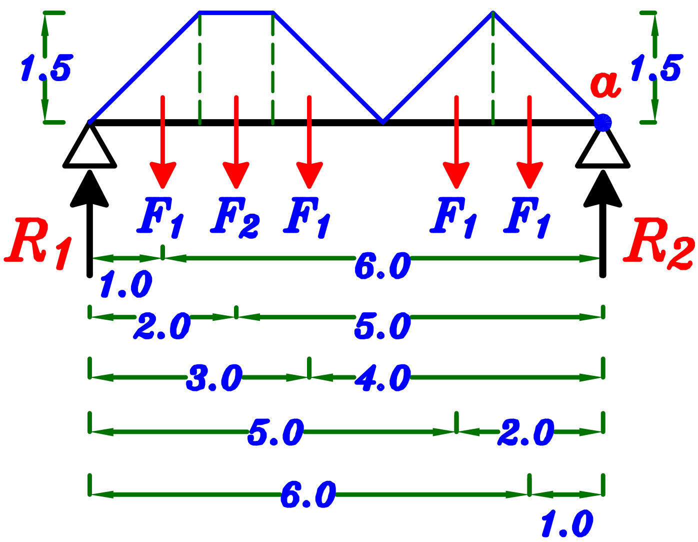
For the given beam Calculate the max shear and bending using Exact method.





$$F_1 = area * W_s = (0.5 * 1.5 * 1.5) * W_s = 1.125 * W_s$$

$$F_2 = area * W_s = (1.0 * 1.5) * W_s = 1.5 * W_s$$

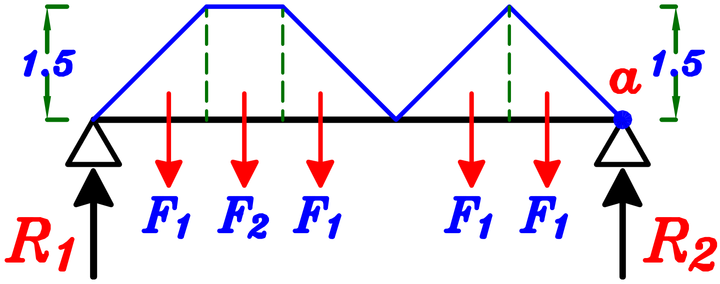


To calculate Reaction R_1 Take moment about point a = Zero

$$F_1(6.0) + F_2(5.0) + F_1(4.0) + F_1(2.0) + F_1(1.0) - R_1(7.0) = Zero$$

$$(1.125 * W_s)(6.0) + (1.5 * W_s)(5.0) + (1.125 * W_s)(4.0) + (1.125 * W_s)(2.0)$$

$$+ (1.125 * W_s)(1.0) - R_1(7.0) = Zero \longrightarrow \boxed{R_1 = 3.16 * W_s}$$



$$R_2 = 4 * F_1 + F_2 - R_1$$

$$= 4\,(1.125 * w_s) + (1.50 * w_s) - 3.16 * w_s = 2.84 * w_s$$

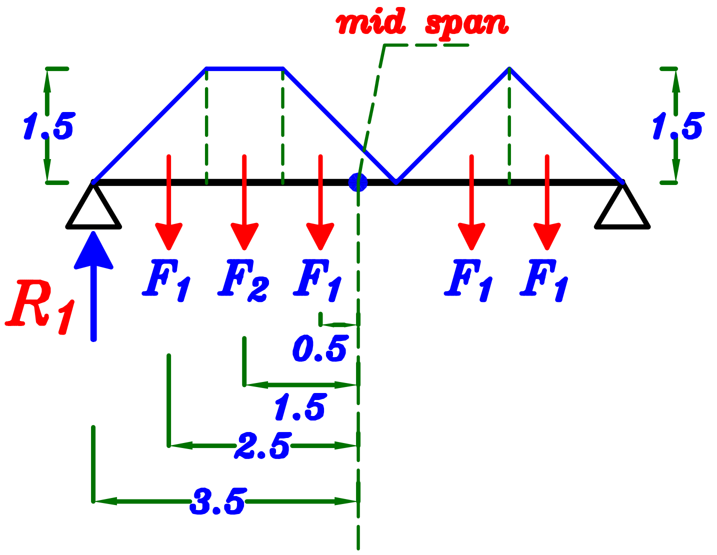
$$\boxed{R_2 = 2.84 * w_s}$$

$\therefore$ max–Shear Force = The bigger Reaction value.

$$\boxed{\text{max–Shear Force} = R_1 = 3.16 * w_s}$$

Assume that max moment

is at mid span point



Bending moment at mid span

$$= R_1(3.5) - F_1(2.5) - F_2(1.5) - F_1(0.5)$$

$$= (3.16 * w_s)(3.5) - (1.125 * w_s)(2.5) - (1.5 * w_s)(1.5) - (1.125 * w_s)(0.5)$$

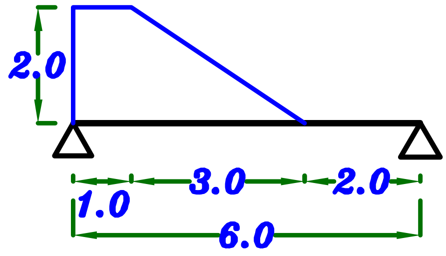
$$= 5.435 * w_s$$

$$\boxed{\text{max–Bending moment} = 5.435 * w_s}$$

Example.

Calculate the value of C_a & C_e For any shape.

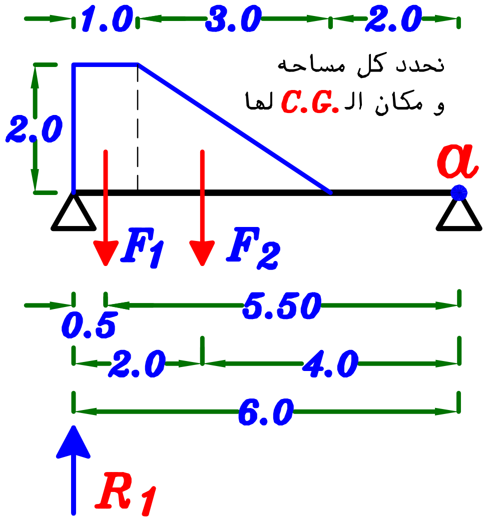
For the Given shape. Calculate C_a & C_e

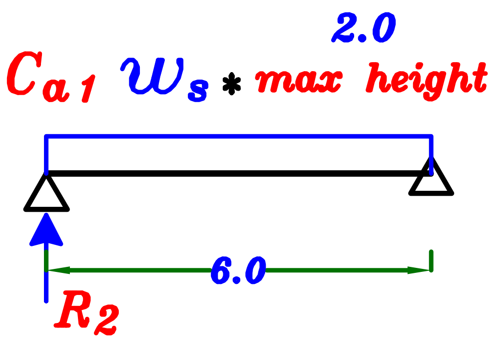


مثال توضيحي من الممكن ان يكون الشكل و الابعاد مختلفه .

$\underline{\underline{C_a}}$ For Left Reaction. R_1

نحسب R_1 بالارقام و نحسب R_2 بدلاله C_a ثم نساويهم ببعضهما و نحدد قيمه C_a





$$F_1 = area * W_s = (1.0 * 2.0) * W_s = 2.0 * W_s$$

$$F_2 = area * W_s = (0.5 * 3.0 * 2.0) * W_s = 3.0 * W_s$$

To calculate Reaction R_1 Take moment about point a = Zero

$$F_1 (5.5) + F_2 (4.0) - R_1 (6.0) = Zero$$

$$(2.0 * W_s)(5.5) + (3.0 * W_s)(4.0) - R_1 (6.0) = Zero$$

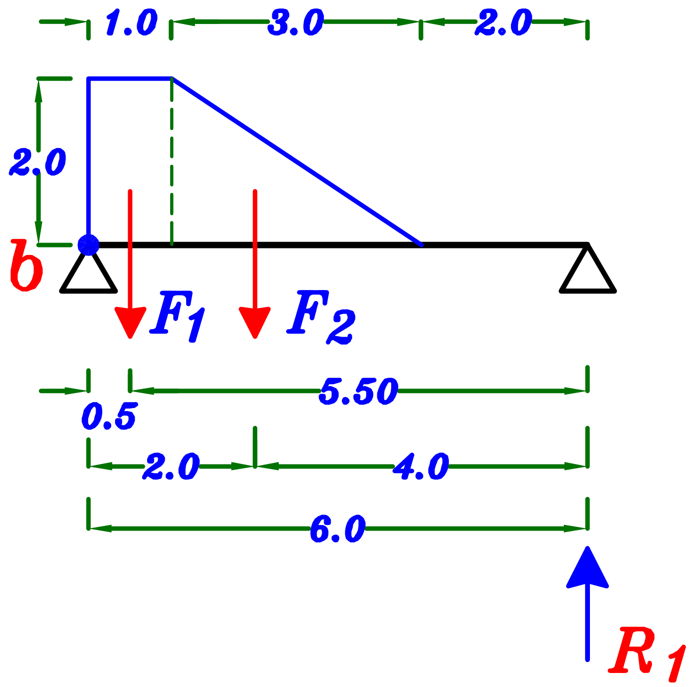
$$\longrightarrow \boxed{R_1 = 3.83 * W_s}$$

$$R_2 = \frac{\sum Load}{2} = \frac{\overset{w}{(C_{a1} * W_s * 2.0)} * \overset{L}{6.0}}{2} \qquad \boxed{R_2 = C_{a1} * W_s * 6.0}$$

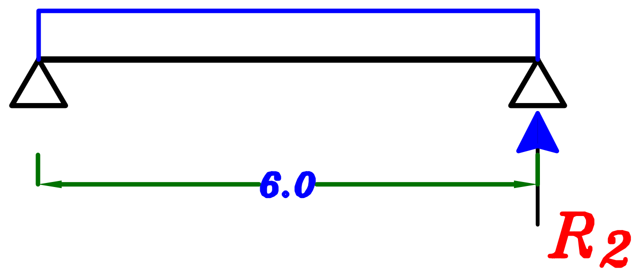
By taking $R_1 = R_2 \longrightarrow 3.83 * W_s = C_{a1} * W_s * 6.0$

$$\boxed{C_{a1} = 0.638}$$

$\underline{\underline{C_a}}$ For Right Reaction R_2



$\overset{2.0}{C_{a2}\ \mathcal{W}_s * max\ \ height}$



To calculate Reaction R_1 Take moment about point $b = Zero$

$$F_1\,(0.5) + F_2\,(2.0) - R_1\,(6.0) = Zero$$

$$(2.0 * \mathcal{W}_s)\,(0.5) + (3.0 * \mathcal{W}_s)(2.0) - R_1\,(6.0) = Zero$$

$$\longrightarrow \boxed{R_1 = 1.16 * \mathcal{W}_s}$$

$$R_2 = \frac{\sum Load}{2} = \frac{(\overset{w}{C_{a2} * \mathcal{W}_s * 2.0}) * \overset{L}{6.0}}{2} \qquad \boxed{R_2 = C_{a2} * 6.0 * \mathcal{W}_s}$$

By taking $R_1 = R_2$ $\quad 1.16 * \mathcal{W}_s = C_{a2} * 6.0 * \mathcal{W}_s$

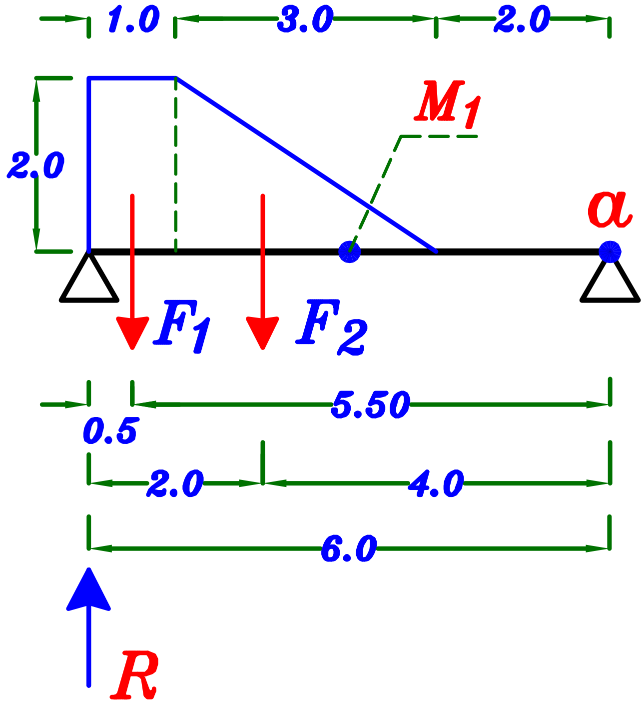
$$\boxed{C_{a2} = 0.193}$$

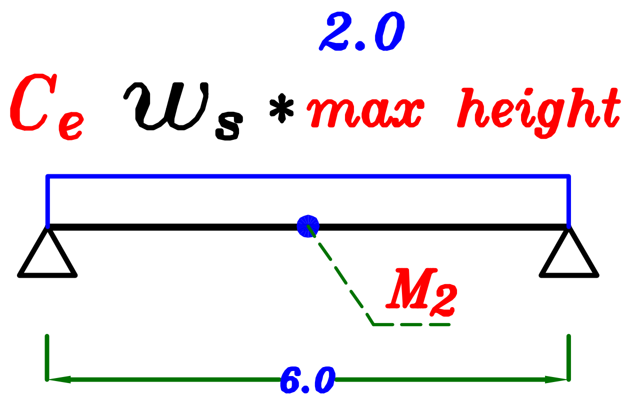
$C_{a1} = 0.638$ $\qquad\qquad$ $C_{a2} = 0.193$

C_e

لكى نحسب قيمه C_e بدقه نحتاج معرفه مكان نقطه **max moment** أى عند نقطه **zero shear** و لانه صعب جدا تحديد مكانها للاشكال الغير منتظمه اذا للتسهيل سنعتبرها فى منتصف الكمره .

نحسب M_1 فى منتصف الكمره بالارقام و نحسب M_2 فى منتصف الكمره بدلاله C_e ثم نساويهم ببعضهما و نحدد قيمه C_e





$$F_1 = area * W_s = (1.0*2.0)*W_s = 2.0*W_s$$

$$F_2 = area * W_s = (0.5*3.0*2.0)*W_s = 3.0*W_s$$

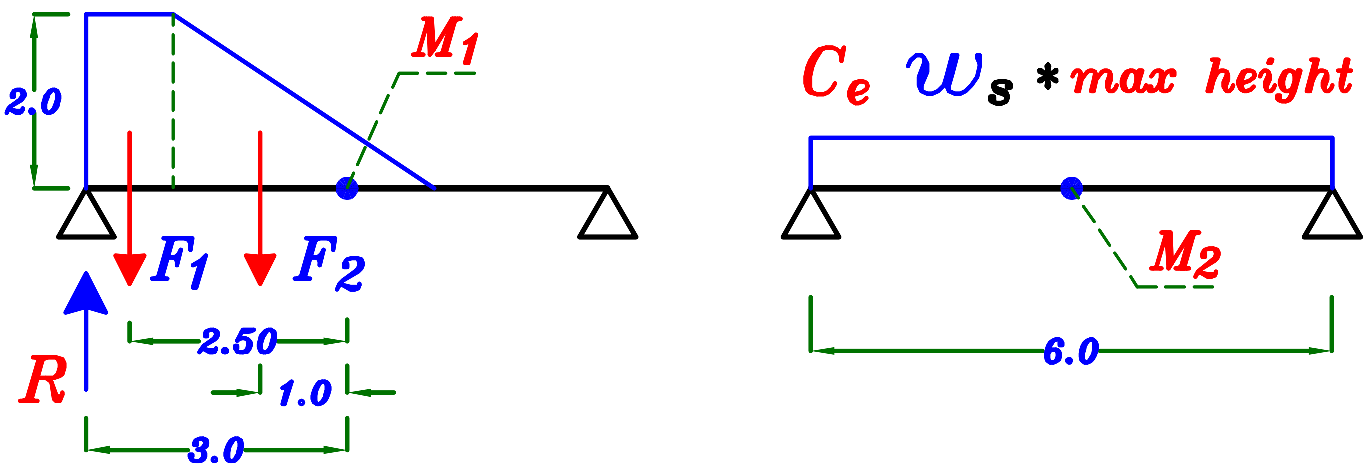
To calculate Reaction R Take moment about point a = Zero

$$F_1(5.5) + F_2(4.0) - R\,(6.0) = Zero$$

$$(2.0*W_s)(5.5) + (3.0*W_s)(4.0) - R\,(6.0) = Zero$$

$$\longrightarrow \boxed{R = 3.83*W_s}$$

Calculate the bending moment at mid span



Calculate M_1

$$M_1 = R\,(3.0) - F_1\,(2.5) - F_2\,(1.0)$$

$$= (3.83 * w_s)\,(3.0) - (2.0 * w_s)\,(2.5) - (3.0 * w_s)\,(1.0)$$

$$\boxed{M_1 = 3.49 * w_s}$$

Calculate M_2

$$M_2 = \frac{w L^2}{8} = \frac{(C_e * w_s * 2.0) * 6.0^2}{8}$$

$$\boxed{M_2 = C_e * w_s * 9.0}$$

By taking $M_1 = M_2$

$$3.49 * w_s = C_e * w_s * 9.0$$

$$\boxed{C_e = 0.388}$$